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NATURE STUDY
WITH COMMON THINGS

CARTER

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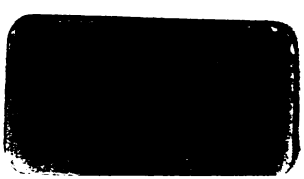

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NATURE STUDY

WITH

COMMON THINGS

AN ELEMENTARY LABORATORY MANUAL

BY

M. H. CARTER

DEPARTMENT OF ELEMENTARY SCIENCE, NEW YORK
TRAINING SCHOOL FOR TEACHERS

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W. P. 2

PREFACE

It is the intention of this book to provide a laboratory guide for young pupils; a guide which shall introduce them to, and give them practice in, *method of procedure* in laboratory investigation. Since the foundation of all science lies in observation, the work here given is planned with a view to training and developing the power of accurate observation, of critical examination, rather than the reasoning processes which depend for their results upon the accuracy of the data obtained first through observation.

The child must be taught to see before he is taught to explain; he must learn to answer the question *what is it?* if he is ever satisfactorily to answer *why is it?* He must get his mental image clear and complete by using all of his senses upon the object before he can understand it, or draw conclusions from what he learns. For this reason many of the observations the pupil is called upon to make in these lessons bear upon no conclusion. They make no attempt to explain anything, but are for the sole purpose of being made.

For this reason also many observations lead nowhere logically, many problems suggested remain unsolved, many *whys* unanswered. For the child this should be so. His work in science should leave him with a sense of accomplishment, but not of finality. Some *whys* must be left unanswered to lead

him onward; many, he can answer for himself; some, no one can answer.

Each object here given should be studied in a single lesson, by a single effort as it were, and each lesson has been calculated as closely as possible to occupy an hour exclusive of drawings or written work. If more time is available, it would better be devoted to the study of some other branch, such as birds or insects, not to a second lesson in laboratory work.

The lessons are planned to set forth what a child can learn for himself about a given thing in one hour, not to teach all that is known, or even all that he himself can know by unlimited study upon it. This is not a handbook of information, but a practical class-room guide, intended solely to develop the method of *learning how to learn.*

Though the lessons deal with botanical specimens, many scientific botanical facts must necessarily remain untaught. It is only in university work that it is conceivably possible to teach all that is known about any one object, while in the school grades effective teaching must disregard much in order that the attention of the pupil may be concentrated on a few facts and the process of observation be developed.

This course can, however, be used as an introduction to the study of botany in advanced grades where pupils have had but a limited experience in handling specimens, observing, and drawing, as the specimens all illustrate some interesting plant structure. The lemon, orange, and cranberry are *berries;* the plum and cherry are *drupes;* the pea a *pod* and a *seed;* the potato a modified *stem;* the beet, carrot, and radish *modified roots* and *shortened stems.* To this may be added asparagus, a *stem* with an *apical bud;* celery, a beautiful example of

modified leaf stem; and cabbage, a *gigantic bud,* and probably the most perfect specimen in the world for the study of bud formation.

The specimens were selected largely with economy in view, since many teachers are obliged to provide their own material for nature study, and therefore the cheapest and most common have been given the preference.

The laboratory exercises should be closely correlated with oral language in the form of question and answer, and to this the lessons lend themselves readily. The topics are so arranged as to be cast into questions by the teacher with the words "*Do you see* —" or "*Have you found* —" the skin, stone, midrib, etc.; "*What is* —" the color, taste, smell; or "*Describe* —" the taste, smell, *knock-sound, pinch-sound,* feel of the skin, etc.; and the teacher can thus appear at the best advantage before her class, because she can take an active part in the lesson and follow it closely from the book without being in the least mechanical.

The lessons may be used as a basis for written language, but this should never under any circumstances be given upon the same day as the lesson. The written work must be looked upon as a *memory test,* not *as an exposition of facts.* The written work can never perform the same function for the adult and the child. In the first place, the adult has written language at command, the child has not; in the second, the college student who takes notes is preparing himself for science, the child is getting the preliminary processes before his preparation can be begun; therefore, the best results of the nature lessons are lost when the teacher tries to turn them into compositions or scientific descriptions made from the object.

It is perfectly right to use the new ideas of nature lessons

for written work later, because the child must have ideas before he can write anything at all. But it is just as easy to write a clear-cut paragraph or page describing a carrot the day after — or better two days after — the lesson as it is on the day of the lesson, and this avoids overfatigue and disgust, besides having several distinct advantages.

Oral and written description are a means, not an end, and it is easy to overdo the means and lose sight of the end. The teacher who sets too great a premium upon the language side of nature lessons creates pupils *who want to see only in order to say*, and their cursory and shallow observations dribble away at the ends of their tongues without leaving an idea behind. The child's attention must be held to what he can *see*, not to what he can say, if he is to get a clear-cut mental image.

Another thing a teacher ought scrupulously to avoid is letting the child get the notion that he is making new discoveries except for himself. This thought may stimulate him for the moment, but in the long run it is injurious to his intellectual development. To-day it is almost beyond the bounds of human possibility that a child should discover an unknown fact in the sciences, and the thought that he can do so will either engender in him an arrogant self-conceit, or it will entail a cruel awakening which may convince him that all effort on his part is useless. The ideal to hold before the young student is the desire to see and learn for himself all that others have seen and learned before, and then more if he can.

Lessons should be conducted with rapid, energetic work on the part of both teacher and pupils and with no unnecessary questions or conversation. Some things the child can discover without help; others he must be guided to see. The aim of

such lessons as these is *vivid experience, not intellectual feats;* hence the pupil is constantly told to "notice" this or that point, that is, to *corroborate a fact* stated; and the exercises are so planned as to keep such balance between facts discovered and facts verified that when the work is finished on any one object that object will stand out in the pupil's mind as a distinct and complete whole.

Never review an old lesson before beginning a new one. The time thus spent is worse than wasted. The mental image of an object as such is not necessary to the mental image of another object. *It is not the mental images that are carried over from lesson to lesson, but the mental processes by which a thing in the thing world is translated into a thought in the thought world;* these are left as an increasing residuum after each lesson, and are ever ready to seize and assimilate the new. Nothing is gained by stirring up a sediment of old memory images as a preliminary to the new work, and time, interest, and freshness are lost.

But when the whole set of lessons is complete, we have in hand material for a general survey or summary of all that has been done, and a summary far more rich and interesting because summarizing is quite a new kind of thing for the child to do.

Each plate tells a story, and each stands as an example of simple and straightforward description. Each line in a scientific drawing should be a language correlative in the description of the object studied. If the pupil describes a leaf as having a midrib, veins, serrate edge, his pencil should say these things with the same clean-cut accuracy. The plates stand as models of arrangement and description, and are varied as much as possible to show different ways of stating a fact with pencil and

brush. Pupils should make their own plates from the object, and color them, arranging their studies after the plates.

This entire work is intended for and adapted to the city schools. It calls for the simplest apparatus, the cheapest material. It asks only for school desks, paper to cover them, knives and pins, pencils and paper.

The lessons are suitable for fourth, fifth, or sixth years, either fall or spring term, but should not be taken earlier than the fourth, and it is believed they will successfully solve the problem of an adequate training in elementary laboratory methods for any one of those years under the conditions obtaining in the city schools.

I am indebted for several suggestions in the plates, viz., pear, plum, and strawberry, to the great French work *Le jardin fruitier du Muséum*, by Joseph Decaisne, and to Koehler's *Medicinal-pflanzen* for the orange twig. Otherwise the plates were done from life.

A large part of the value of this work is due to my former Training School pupils, who, during the past few years, have tested these lessons in the New York schools; to them, and to the principal of the school, Mr. Augustus S. Downing, most of the credit of this little book belongs. But for them it would never have been undertaken and brought to completion in its present form.

M. H. C.

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ARRANGEMENT BY TERMS

FALL TERM	SPRING TERM
1. Blackberry.	1. Pea.
2. Plum.	2. Cranberry.
3. Pear.	3. Radish.
4. Grapes.	4. Potato.
5. Radish.	5. Apple.
6. Potato.	6. Apple Blossom.
7. Apple.	7. Lemon.
8. Apple Blossom.	8. Orange.
9. Lemon.	9. Onion.
10. Orange.	10. Beet.
11. Onion.	11. Carrot.
12. Beet.	12. Strawberry.
13. Carrot.	13. Cherry.
14. Pea.	14. Blackberry.
15. Cranberry.	15. Summary I.
16. Summary I.	16. Summary II.
17. Summary II.	17. Summary III.
18. Summary III.	

Lessons on Strawberry and Cherry omitted in fall term.

Lessons on Pear, Grape, and Plum omitted in spring term.

BLACKBERRY

THE BLACKBERRY

Material

Five or six blackberries per pupil. For this allow at least one quart box for twenty pupils. Pins; sharp knives; small pieces of white blotting paper.

If possible, have pieces of bramble to show stem, thorns, leaves, and the old hull, or calyx, from which the berries have been picked or have fallen. This can be procured in the summer from wild blackberry vines and dried. The leaves may be dried on them also, or may be removed and pressed. By cutting stems in four or five inch lengths while they are fresh, they can be packed in a small box and transported without trouble. If the stems are not thoroughly dry before packing, they will mold.

In packing sprays with the calyx it is advisable to wrap each separately in a bit of paper, otherwise they will be badly damaged in the unpacking.

Laboratory Work

1. Lay the blackberries in a row and pick out a good one. Examine this and notice —
   a. *Color.*
   b. *Shape.*
   c. *Size.*
   d. *The little black balls which make it.*
   e. *The shininess of the berry.*
   f. *The two ends.*

      Note that one end is rounded; the other has a small, round spot in a depression. What is the color of this spot?

      Lay this berry aside to use as a model for drawing.

2. Take a second blackberry and hold it lightly between the fingers of the left hand. With a pin prick one of the small black balls. What comes out? To see the real color of this juice touch it to the piece of white blotting paper.

   Prick three or four of the round balls and blot the juice on the paper. What color is it? Describe it.

3. Hold the blackberry so that the end with the round whitish spot is up. Stick a pin into this spot. Does any juice flow?

4. Stick a pin into one of the small balls. Can you feel anything hard inside of it? Try several balls in this way with a pin and see if each has a hard body inside.

5. Has the blackberry a *smell?*

6. Eat a blackberry by chewing very slowly. What is its taste? Was it all soft, like a peach, or did you feel some small hard things in it?

7. With a pin pick off one of the small round balls. Lay it on the blotter and with the help of a second pin open it out. Inside there should be a small hard body. *This is a seed.*

   Clean off all the pulp around the seed. What shape is it? What color?

8. Pick off five or six of the small balls around the end with the whitish spot. What are they fastened upon?

Vertical Section

9. Cut a *vertical section* of the blackberry, and cut from one end to the other so that the knife goes through the center of the white spot. This must be very carefully done with a sharp knife, or the blackberry will be mashed. Notice the *white or pinkish core* that runs through the middle. What is fastened to it on each side?

Cross Section

10. Cut a *cross section.* Here the core shows a round spot with the balls fastened around it.

The juice will probably stain the cores of both sections so that they appear as pink or purplish pink.

11. If you have pieces of the stem, examine them; if not, look at the plate and notice the *sharp thorns.* Which way do the thorns turn?

Notice how the blackberries are fastened to the stems, and the *little brown hulls* above them.

One blackberry in the picture has been picked off, leaving the hull. Which is this? Notice the

five points or leaves; the *round white spot on the hull.* This spot exactly fitted the round spot on one end of the blackberry.

12. Look at the leaves. How many parts, or leaflets, have they? Notice the edges of the leaves. They look like the teeth of a saw; from this they get their name, *serrate*, which means *saw-toothed.*

13. Look at the blackberry blossoms on the upper part of the plate. Find one that is wide open; count the petals.[1] Notice the *fringe*, made of fine threads with little balls on the ends of them. The balls are yellow in the real blossom. These are called *stamens*, and the little balls have a powder which makes the blackberry grow.

    Notice the *small spot* in the middle. In the real blossom this is green and is the *baby blackberry.* When it begins to grow, the petals fall off, but the fringe does not. It dries up and turns brown. Now if you look at the hull where the berry has been picked off, you will see that the little fringe is still there, dry and brown.

14. Look at the blackberry blossoms and find one wide open; one not so wide open; one nearly closed; one more closed; a bud, and very little bud.

[1] The teacher must here explain the meaning of *petal, stamen, calyx.*

Information

Early in spring the little blackberry buds unfold and the blackberry bush is covered with beautiful white flowers. Their petals are the thinnest and frailest of all our fruit blossoms and look as though they would melt away into the air. They are soon gone and then you may see the bunches of tiny green berries.

The leaves and stems and thorns are at first green, and the thorns are quite soft. But as the summer advances their color changes. The stems turn brown; the leaves become yellow, brown, or often a lovely deep red. The thorns grow sharp and as hard as the claws of a cat.

Blackberries usually grow on rather low bushes. These are often called vines because some of the branches, or shoots, grow to be very long and look like vines. But these vinelike shoots do not bear fruit until they are broken or cut off. The wind does this sometimes for the wild blackberry, but when the plants are cultivated they are carefully cut with a knife or clippers. This is called *pruning*.

There are many varieties of blackberries, both cultivated and wild. Among the wild ones there is a vine that is often found along the country roadsides bearing large juicy berries. These are called dewberries.

Blackberry bushes are so protected by their clawlike thorns that very few animals ever get a taste of the berries. The birds, however, can easily pick them without being caught by the thorns, and they eat a great many of them.

But there are two other little creatures who enjoy ripe black-

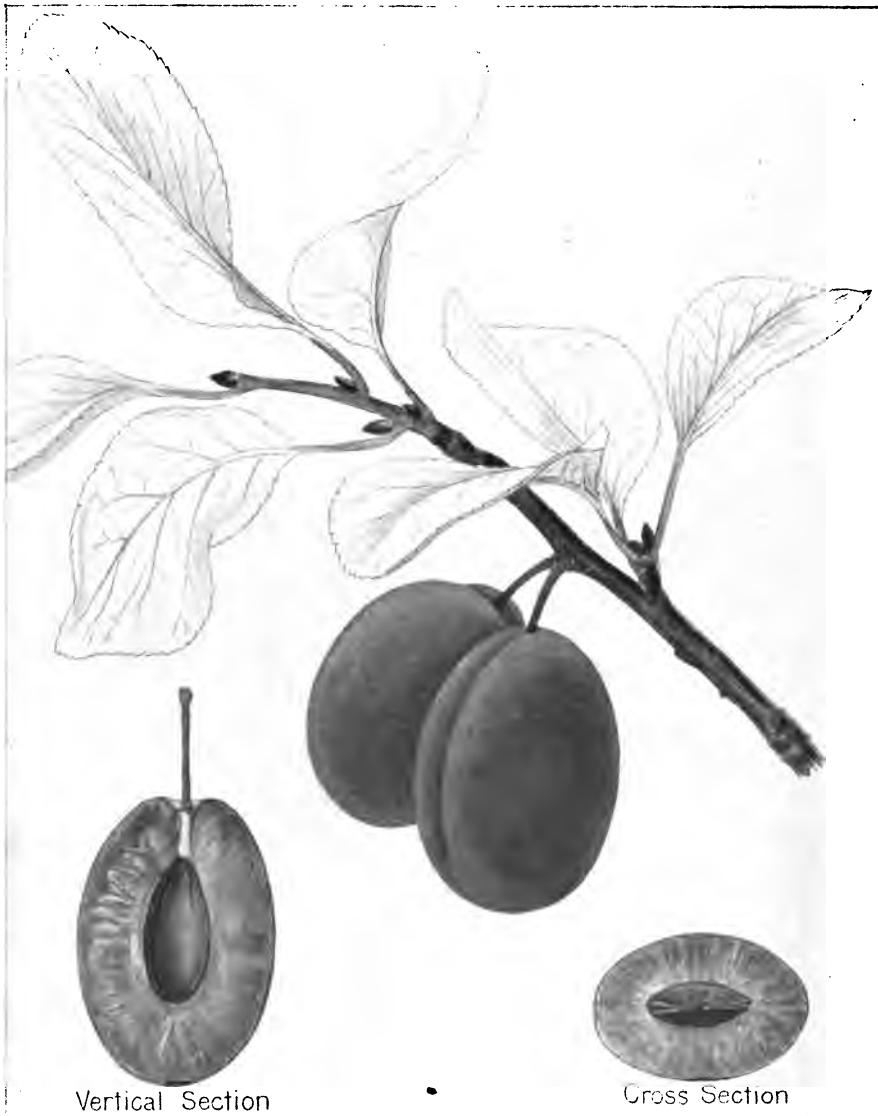
berries as much as we do — ants and wasps. Perhaps you have already discovered that by sad experience!

Country people will sometimes tell you that the wasps *sting* the best blackberries. If you ask them why the wasp should sting a blackberry they do not know. Now the fact is that the wasp is hungry and when he finds a dead-ripe blackberry he simply sucks the juice out of one of the tiny little seed balls very much as you would suck an orange. But if you try to pick that berry while the wasp is eating his lunch — well, you know what happens!

The ants, too, select only the best berries. Sometimes you wonder how the ants got into your berry pail. You put them there yourself without knowing it.

Drawing

1. Make a drawing of the whole blackberry laid aside in Section 1.
2. Make a drawing of a vertical and a cross section the exact size of the real berries.
3. Make a drawing of a piece of stem and show thorns. [The plate may be copied.]
4. Copy a leaf from the plate showing the three parts; the serrate edge.
5. Copy a blossom and a bud from the plate.



PLUM

THE PLUM

Material

Two blue plums per pupil. If possible get plums with stems on. Pins, knives; bits of blotter; hammer.

Laboratory Work

1. Examine a plum and notice —
   a. *Color.*
   b. *Shape.*
   c. *Size.*
   d. *The stem* (if present).
   e. *The small hollow, or depression,* at one end where the stem is attached.
   f. *The small spot, or point,* at the end opposite the stem.
   g. *The line, or groove,* on one side of the plum, that runs from the stem to the point.
2. Look at the color carefully, and notice a *whitish shade* which is over the whole or a part of the plum. This is called the *bloom.* Rub this bloom gently with your finger. Does it come off? Is the color under it different from the rest of the plum? How?

3. Has the plum a *smell?*

4. Hold the plum in the right hand with the right thumb pressing upon one cheek. Give a quick, but gentle pinch with the thumb. Has the plum a *pinch-sound?*
5. Prick the plum with a pin. Does any *juice* come from the pin hole? What color is this? If no juice follows from the prick, squeeze the plum very gently, until a small drop is seen above the hole. In order to see the color touch the drop with the blotter. What color is the juice?
6. Run a pin into the side of the plum. Does the pin go in up to the head? Does it strike *something hard?* Try different parts of the plum and see if the pin meets something hard each time.

Vertical Section

7. Cut a *vertical section* of the plum by setting the knife in the groove and cutting around the plum. Open out the halves. Notice the *hard, reddish brown stone*, or pit, in the center; the *greenish yellow pulp* around it; the *thin purple skin* outside of the pulp; the *lines, or threads*, running through the pulp from the stem end.
8. Examine the stone carefully and notice that it is long and narrow; the plum is also long and

narrow; now state exactly how the seed lies in the plum.

Notice also the *ridges* running along the outer edge of the stone.

9. Lift out the stone and see how flat it is, and also see the ridges on the other side of the edge. Make a statement concerning these ridges and the edge.

Press the pit between the finger and thumb. Press the edge of the desk between the finger and thumb of the other hand. Compare the hardness of each. Would you describe the plum stone as "hard" or "very hard"?

Cross Section

10. Cut a *cross section* through the middle of the second plum. Open the halves so that the stone will be left sticking up in one half. Now notice that the stone lies just the same way in this section as it did in the vertical section; that is, the long and narrow way of the stone lies in the direction of the long and narrow way of the plum.

Look on the outside of one half of the plum for the *groove;* does this lie over a flat surface of the stone, or over an edge?

11. The stone contains the *seed*. To see this, hold the stone on one edge and strike it with a hammer. It will split open and show the seed, which is generally called the *kernel*.
12. Look at the plate and notice the *leaves* of the plum. Describe one of the leaves. What kind of an edge has it?

    Compare this leaf with the blackberry leaf. If you do not know the name given to a *saw-toothed edge* read what was said about the blackberry leaf.

    Describe the way in which the plums hang from the branch or twig.

Problem

Here is a problem about the plum which you may be able to work out at home some day when you have a plum: There are some ridges on one edge of the plum stone, which you see at once as soon as you cut the plum open. Is there any way in which you can tell, *before* you open the plum, whether they will lie to the right or the left as you hold the plum with the stem up?

Information

The plate shows only a small branch or twig from a plum tree having two plums on it. The blossoms of the plum are pure white and look very much like pear blossoms. The tree is not very large, being about the size of a peach tree, and very much smaller than a full-grown apple tree.

All plums are not purple, as you probably know, and some are very much larger than the plums shown in the picture, while others are smaller. Have you ever seen a green, a yellow, or a red plum?

There is a small plum that grows wild along the eastern sea coast called the beach plum. It is not very good raw because it is bitter and *puckery*, though some people say they like it. These are used for jam and jelly and preserves.

Some of you may have been on a beach-plumming picnic and know what fun it is. Big baskets of lunch are taken and the whole family goes. All day long everybody picks. The lunch-baskets, when emptied of their lunch are filled again with plums.

Most beach plums grow on very low trees, almost like bushes, and one can sit comfortably on the ground to pick them.

If the plums are plentiful one day's work may mean plum jam for the whole winter.

Have you ever eaten stewed *prunes*, or prune pie? Did you know that prunes were plums too?

They do not look very much like the rich purple plum you eat in the early fall, but that is because they have lost their color by drying.

If you examine the stones or pits of the prunes the next time you have them you will find them exactly like the plum stones we have been studying.

All plums do not make good prunes, so special kinds are raised for this purpose. In California, Colorado, and many other western states there are vast orchards of plum trees the fruit of which is used for prunes. The plums are picked and dried in the hot

sun and then packed in boxes to be sent all over the country, and even to remote parts of the world. For plums not only keep a long time if they are properly dried, but they do not lose their flavor as many other fruits do.

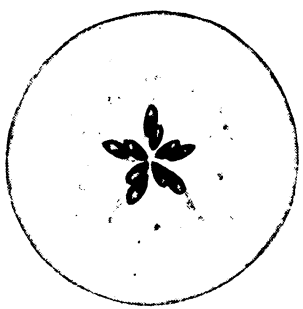
Perhaps it never occurred to you that the stewed prunes you had for supper a few days ago were plums on a tree in California last summer!

The Japanese are very fond of plums and have cultivated them until they have many wonderful varieties. Think of a plum as large as an apple and sweeter and juicier than a peach! People in America are beginning to import some of these wonderful Japanese trees and it may not be many years before plums as large as apples will be as common as our ordinary purple plum.

A plum orchard in blossom is a beautiful sight. Every branch and twig has its little bunch of pure white flowers looking as though a snowstorm had visited them in the night. And when the petals fall the breezes blow them about like snowflakes, dancing and fluttering along until, like the snowflakes, they settle upon the ground and in a few days disappear.

Drawing

1. Draw a whole plum showing exact shape and size.
2. Draw a vertical section and a cross section and show how the stone lies in the plum.
3. Draw the stone and show the ridges. Put these in correctly.
4. Draw a leaf from the plate, and show edge and veins.


Cross Section

PEAR

THE PEAR

Material

One pear for each pupil. In making sections every alternate pupil may cut a cross section, the other cutting vertical sections and exchanging the halves. The drawing of the whole pear must be made before cutting; that is, after § 6. Pins; knives.

Laboratory Work

1. Examine the pear and notice —
   a. *Shape*, which gives us the word "pear-shaped."
   b. *Size.*
   c. *Color.*
   d. *Spots, or markings on the skin.*
   e. *Stem.*
2. Look at the stem and see how it is fitted into the pear. Describe this.
3. Look at the end opposite the stem; notice the hollow or depression, in the bottom of which are some *small dry points.* Count these. There should be five if none are broken off. What is their color?
4. Has the pear a *smell?*
5. Hold the pear close to your ear and pinch it with your thumb. Has it a *pinch-sound?*

Knock it on your desk. Do you think it sounds like the knock of a *hard* or of a *rather soft* thing?

6. With a pin pick off a little piece of the skin. Notice the *white pulp* underneath; the thinness of the skin.

Cross Section

7. Cut a *cross section* through the widest part of the pear. [Alternate pupils do this.] Notice the *core* and its *five divisions.* In the pear some of these are apt to be imperfect.

   Notice the *seeds* in the divisions of the core. Count these. There should be ten, but often the seeds do not ripen, and then they are no larger than pinheads, and are hard to find. Are there any of these undeveloped seeds in your pear?

8. Find the *ring of dots* around the core. How many distinct dots are there?
9. Notice that the core is in the center of the pear, embedded in white pulp, with a narrow rim of skin outside.
10. Look closely at the pulp. Do you see near the core and scattered throughout a quantity of small dots? With the knife cut a very thin slice of the pear about the size and thickness of the finger nail.

Crush this between the thumb and finger. Can you say now why the pear had no pinch-sound?

11. If the slice cut for § 10 had in it any of the small dots, rub it between the finger and thumb and see whether they are hard or soft. If there were none, scrape a little of the pulp near the core and rub between the thumb and finger. These spots are called *grit cells;* do you know why?

Vertical Section

12. Cut a *vertical section* of the pear. [Alternate pupils do this, exchanging.] Begin at the stem end. Hold the knife close to the stem and cut down, right through the middle of the pear.

Notice the *core* and the *core plates.* The core plates look something like finger nails.

13. Notice the *seeds.* What is their shape? In which direction does the seed point with its sharp end?
14. Notice *how the stem is fitted into the pear*, and the *long fibers* that run around the core. What is their color in your pear?

15. Notice the end opposite the stem. See how the little dry points really cover and conceal a *small*,

round hollow. This end of the pear is called the *blossom end,* because the petals were attached here just inside the five points and around the hollow.

16. Hold the half of the pear with the stem in it in the left hand. With the right hand gently raise the stem and pull it toward the core. Do this slowly and see how the fibers fit into the pear.

Pull the stem quite out and find the *paint brush* on the end of the stem. Rub this back and forth on a bit of paper and notice how hard and bristly the fibers are.

17. Look at the plate in the book and notice the leaves of the pear. What is the shape of a leaf?

Examine the edge. What kind of an edge is this? What is it called? What other fruit has a leaf with this sort of an edge?

Look back over the other lessons and find leaves with this edge.

Information

In the picture of the pear there is a drawing of a twig in blossom. The flowers are white and have five petals. In the center of each flower is a little tuft of fine, white hairs, on most of which is a reddish or yellowish ball. The balls contain a

powder called *pollen* that falls upon the ends of those threads having no balls, and makes the seeds grow. The whole pear grows at the same time that the seeds are growing.

The petals fall off when the seeds begin to ripen, but the fine white threads remain behind and turn brown. They can still be seen even after the pear is ripe. If you raise two or three of the points at the blossom end, you will find them hidden away.

Pear trees bear a great many blossoms, but only a very few become large pears and ripen. Most of the pears drop off when they are very small and only the best live to maturity.

There are a great many different kinds of pears, and they vary in color, size, and taste. In fact there are almost as many kinds of pears as there are kinds of apples.

The colors of pears are not so varied as the colors of plums, being yellow, green, or brown, with sometimes a blush of red on one cheek. Nobody has ever seen a purple pear, and, perhaps, like a blue rose, it is one of nature's impossibilities.

One of the best of all pears is the Seckel pear, and it is one of the most interesting too; for there is a mystery about it that has never been solved.

Nearly a hundred years ago, in 1819, a tree was found growing on the farm of a Mr. Seckel, near Philadelphia. It was filled with small, but delicious fruit. How it came there nobody ever knew, but there it was. In a few years the pears became famous in the country round about. Being so unlike other pears and growing on only one known tree, they were always spoken of as *Seckel's pears*, and the name has clung to them ever since.

Cuttings and buds from this tree were obtained by growers,

and many thousands of trees were raised directly from it. They were even sent to Europe, where they are now widely cultivated, though the name is often changed to Sack pear.

The pear is cousin to the apple. If you want a problem to work out for yourself, here it is: Find out by examining the fruits and the blossoms of both pear and apple in how many particulars they agree; in how many they differ. (Counting will help you here.)

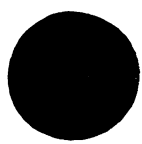
Here is another problem: The pear has a cousin among the garden flowers. She is very well known, highly prized, and widely cultivated. What is her name?

Drawing

1. Make a drawing of the whole pear.
2. Make a drawing of the cross section.
3. Make a drawing of the vertical section.
4. Copy a leaf from the plate.

Vertical Section

Cross Section



GRAPE

GRAPES

Material

A bunch of grapes per pupil. Concord or other purple grapes if possible. White grapes would better not be used for this lesson, because the layer of coloring matter next the skin and not in the pulp will not be shown clearly to young pupils. Pins; knives; bits of blotter.

Laboratory Work

1. Hold a bunch of grapes up by the stem. Notice its *general shape.* If the bunch is a typical one, you will see that it is *thicker* at the stem end, and *narrower* at the end opposite. What makes the bunch of grapes this shape?
2. Look at the separate grapes carefully. Are they all exactly the same size? Is there a particularly large one at the end?
3. Holding the stem in your left hand, take a pencil or a small stick and lift some of the grapes in the upper part of the bunch. Find the stem by which these are attached to the main stem.

   Notice that below this small stem there is another stem on which grow several grapes. Lift this with the pencil. Count the grapes on each of these little stems.

   Lift more grapes gently, and see if the stems are attached to the main stem, and go on down the

bunch, *counting the number of grapes* to each little stem or stemlet, until you come to the large grape at the extreme end.

How many grapes are there on the stem having the largest bunchlet?

Where is there but one grape to the stem? Where two? Where several?

Where is there a *little bunch?*

Can you put this into one single statement which gives the *reason* for the shape of the bunch?

4. Notice the general *color* of the grapes, and the *dusty whitish color* which seems to cover the purple. This is called the *bloom.*

   Gently rub the grape with your finger. Does the bloom rub off? What is the color of the grape under the bloom?

5. Pick off a single grape. Notice —
   a. *Roundness.*
   b. *Spot where grape was attached to stem.*
   c. *Tiny spot opposite stem end.*
6. Pinch a grape very gently. Has it a *pinch-sound?* Knock it upon the desk. Describe the *knock-sound.* Do you think from these tests that the

grape is likely to be hard and dry inside, or soft and juicy?

7. Hold the grape with the stem end up and gently squeeze. Notice how the grape *splits* at the spot where the stem was attached. Usually a drop of juice now shows. Touch this with a bit of blotter. What is its color?

8. Hold the grape over a piece of white paper and squeeze out the inside. Notice —
   a. *The roundish pale green pulp.*
   b. *The juice.*
   c. *The thick skin.*

9. Is the grape purple all through? If not, where is the purple coloring matter?

   Open out the empty skin carefully and notice how juicy it is. Lay the skin back over your finger and *scrape the inside* with a pin. Notice the purple coloring matter that comes off.

   Scrape a little piece of skin quite clean; break it off and hold up to the light. What is its color?

10. Examine the pulp that has been squeezed out, and notice how *soft* it is.

    Can you see any small dark bodies inside the pulp?

Run a pin into the pulp in different places so as to strike the dark bodies that lie inside. Are they hard or soft?

11. Pick open the pulp with a pin and take out the little dark bodies inside. These are the *seeds*, and there should be *four* of them.
12. Examine the seeds and notice —
    a. *Size.*
    b. *Shape.*
    c. *Color.*
    d. *Hardness.*
    e. *The crease running from one end to the other.*

13. Suck a grape and notice how *slippery* the pulp is; the *sweet taste* of the juice. Taste this juice carefully, and you may be able to get a *flavor* besides the sweet taste.

    Now *smell* the bunch of grapes. Then suck a second grape and *see if the flavor tastes like the smell.*

Cross Section

14. Cut a *cross section* of the grape. (This must be done with a very sharp knife or it will not be good.) Notice the arrangement of the seeds; the pulp and the skin.

Vertical Section

15. Cut a *vertical section.* Notice which way the seeds point. Try to see how the stem fits into the grape by a *little brush or bunch of fibers,* from which run whitish threads into the grape.
16. Examine a grape still hanging on the bunch. Notice how the little stem spreads into a *small, flat plate,* or "button," where it joins the grape. Pull the grape carefully off the stem, and see if the stem is fastened upon the top of the grape, or if it goes into the grape.

    Look at the vertical section of the grape in the plate and compare your grape with it.

Information

Grapes grow upon vines, not on bushes or trees, as some fruits do. The blossoms appear on the grape vines in the early summer, but are very, very small and pale yellow or greenish in color. Each little stemlet which now holds a grape once had a little blossom upon it.

There are many varieties of grapes and several colors, — purple, blue, red, and white. The white grapes, however, are really a sort of pale green, not white.

Grapes are used for making wine as well as to eat raw. This is done by squeezing the juice out in great presses and letting it *ferment.* When fresh the juice is sweet, but during fermentation

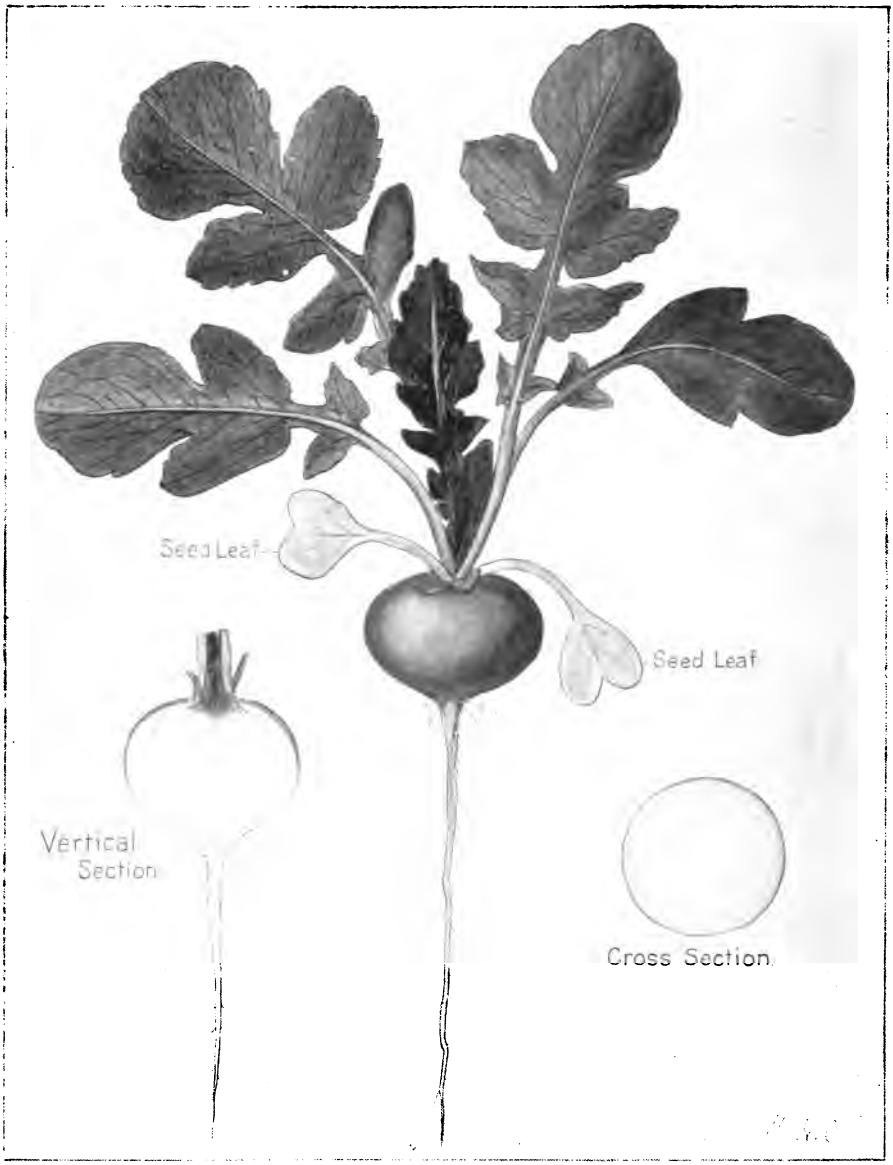
it loses most of its sugar, and in its place there appears a certain quantity of alcohol.

People have known how to make wine from grapes for a great many hundred years. In olden times, before wine presses were invented, and in many places to-day where they are unknown, the juice is obtained by treading on the grapes. The grapes are placed in large tubs with holes in the bottom, and people — men, women, and children — dance upon them, treading out the juice with their bare feet.

In this country the pressing is entirely done by machinery in some form, and never by treading.

Drawing

1. Make a drawing of a whole bunch of grapes which will show how a bunch of grapes is built up.
2. Copy the sections from the plate.
3. Draw a seed from life.



RADISH

THE RADISH

Material

Three or four scarlet radishes per pupil. Knives; small pieces of black paper. At least one radish in full leaf should be given to each pupil, but for the study of the root itself the quality of the leafage is of no consequence. Two grades of radishes are usually to be found at the greengrocer's, the cheaper being the stale radishes, with wilted and damaged leaves. As part of the object of this lesson is to give the pupils an idea of a whole plant, it is necessary that some of the radishes should be quite fresh.

Laboratory Work

1. Take a radish in your hand and notice the *color* and *shape;* the *green leaves; the long, pointed, taillike root* below the round part of the radish.
2. Is the radish the same color all over? Describe this.
3. Examine the radish carefully. Do you find any *small hairlike roots* growing from it? Where are these, on the round part, or on the long, white root?
4. Has the radish a *smell?* Describe it.
5. Pinch the radish with your thumb. Has it a *pinch-sound?* Is the pinch-sound sharp and clear, or rather dull?
6. Select your best radish. Hold this with the leaves

up. Notice where they join the radish. Can you find *one or more pink* scales? How many?

7. Examine the leaves of the radish. What are they covered with? Break off a leaf: now shut your eyes and touch this leaf gently to your forehead; to your lips; to your cheek. Did you notice anything peculiar?
8. Examine the edge of a leaf. This is somewhat "saw-toothed." Compare it with the leaves of the blackberry and the pear in the plates.
9. Look along the leaf stem. Can you find one pair of small green leaves or leaflets below the main body of the leaf that look like *squirrel's ears?*

   See if you can find a leaf with one pair of "squirrel's ears"; a leaf with two pairs; a leaf with three pairs.
10. If you examine a leaf in its widest part you may find a pair of notches. Below the notches are the "squirrel's ears." Look carefully, and you will see a *thin line of green* joining the "squirrel's ears" to the wide part.

    Look at several leaves, and you will find one that seems to have a great many leaflets along the side of the stem. If you examine these leaflets

closely, you will find a *strip of green running from one to another.* This shows that they are not separate leaflets at all, but only very deep notches in one leaf.

11. You can now discover another interesting thing about the radish.

    Examine the *oldest* leaves. These are on the outside of the leaf group. How deep are the notches in these leaves? Now look at a young small leaf in the center of the leaf group; how deep are its notches? Count the pairs of notches in each leaf. How many are there?

    By comparing these leaves you will see that the first leaves the radish sends out are very simple, but each new leaf is more beautiful and complicated. It seems almost as though the radish learned to do better every time it grew a new leaf.

12. Hold a leaf up to the light and notice the *veins.* Notice the large vein or *midrib* that runs through the middle of the leaf; the *branches* of the midrib, the *network of veins.* This is a *net-veined leaf.*

13. Examine the leaf on both sides. Do the veins look the same on the back and on the front? Why not?

14. On the upper side of the leaf where are most of the hairs? Where are they on the under side?
15. Pull off the leaves one by one and notice how they grow out of the radish. Do you find one very tiny leaf in the middle? Why is it there?

Vertical Section

16. Make a *vertical section* of a radish. Notice the *white inside;* the *pink outside;* the *green spot* where the leaves grow out; the *green line* running part way down the middle. Is the pink outside layer *even all over*, or is it thicker in one part of the radish and thinner in another? Where is it thickest?

In some radishes there are small holes near the center, but all radishes do not have them.

Cross Section

17. Make a *cross section.* Notice the *white inside;* the *pink outside.* Is this an *even layer* all around? Notice the *fine lines radiating from the center.* These lines look clearer than the rest of the radish, and resemble little needles of ice, though of course they are not ice.

In some radishes there is a ring of holes halfway to the center; in others a ring of snow-white patches.

18. Cut a *very* thin slice of the radish and lay it on a piece of black paper. In most radishes you can see a pink or a pinkish ring on the outside, and from this start all the clear lines that run to the center. The outside pink line makes a perfect circle around the radish.

Now examine this slice by holding up to the light.

19. Cut a slice of radish and eat it. How does it taste? To what would you compare this taste?

Information

The pink portion of the radish is really a root. Because of its bright color we might take it for a fruit, but for all that it grows in the ground and produces a stem with leaves.

Below the round part the root tapers out. This long, tapering end goes down straight into the ground and sucks up water and food for the leaves which grow above ground.

The interesting thing about the radish is this: the plant stores up food in the root for its own use. It spends the first part of its life in making as large a root as it possibly can. When the root is full grown the outer leaves die and then there comes a long, slender shoot, on the top of which are the flowers of the radish. After the flowers have made their seed, the whole plant dies.

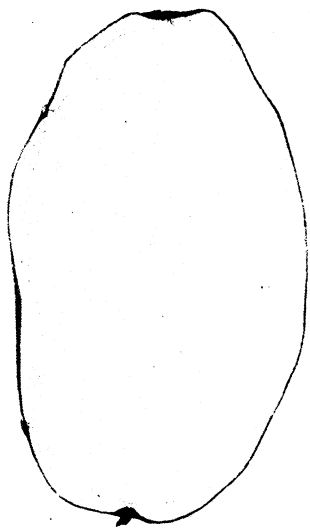
If we dig up the root, after the plant has flowered, we shall

find it quite changed and much shrunken. The reason of this is that the radish plant has used the food it stored up and has produced flowers and seeds.

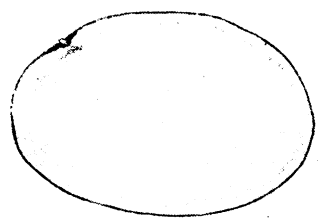
Drawing

1. Make a drawing of the whole radish plant, showing how and where the leaves grow out of it, and the tapering root.
2. Draw a vertical section and show the varying thickness of the pink layer.
3. Draw a cross section and show the pink layer and radiating lines.
4. Draw a leaf and show the wavy outline; the notches; the "squirrel's ears."

Potato



Vertical Section



Cross Section

POTATO

THE POTATO

Material

Two potatoes for each pupil. Pins; very sharp knives. Glasses of water for Section 13. Glass saucers or small glass dishes or watch crystals may be used instead, but are more expensive than glasses. Very small plain glasses used may be bought for three or four cents each.

Laboratory Work

1. Examine a potato carefully and notice its *color* and *shape.* The shape may be long flat, round flat, long round, according to the variety. Which is yours?
2. Notice the peculiar spots all over the potato. The spots are called "eyes." Why? Find the "eyebrow" and the "eye." *How many* "eyes" are there on your potato?
3. Look at the two ends of the potato and compare them. Is there any difference?

   Do you see a small *hollow* on one end? In the center of the hollow is a *small spot.* Find this. The spot is the place where the stem was attached, and sometimes a small piece of stem still remains. This end is the *stem end* of the potato. The other end is the *eye end.* Why?
4. Hold the potato so that an "eye" and "eyebrow" are in the same position as your own eye and

eyebrow, and the eye looks into yours. Which end of the potato is on top, the stem end? The eye end?

5. Hold the potato so that the stem end is down; which way do the eyebrows curve? (This is an important point and must be remembered.)
6. Look carefully at an eyebrow, and right in the middle of it you may be able to find a *very tiny scale*, hardly larger than a pin point. This scale points upward when the brow curves down. (It breaks off easily, so you may have to look at every eye.)

7. Has the potato a *smell?* Describe it.

8. Has the potato a *pinch-sound?* Make very sure of this.

   Pinch the potato and then pinch your desk: compare the feeling of both.

   Take the potato in your fist and hold it at arm's length. Squeeze with all your might. Is the potato hard or soft?

   Now knock the potato on the desk. Is the sound that made by a soft object or a rather hard object?

   From these tests would you think that the potato would be *soft and juicy inside?*

Cross Section

9. Make a *cross section* of one of the potatoes. Notice the *thin rim of skin;* the *solid, whitish interior.*

Was there any juice or water when the potato was cut? Squeeze the halves; can you now tell why the potato has no *pinch-sound?*

Notice the ring of faint dots just inside the skin.

There are some faint markings to be seen in the center. Can you make them out? Describe them.

Vertical Section

10. Make a *vertical section,* cutting exactly through the middle of the stem. How does this section compare with the cross section? Is there anything new shown by this cut?

11. Look at the stem end. You may find some *faint green or greenish lines leading from the stem into the potato.*

Cut through one of the eyes (if the knife did not pass through one with the first cut) and you will see the lines running from the eyes also.

Cut through several eyes and see how the lines run from eye to eye, and finally to the stem.

12. Cut the thinnest possible slice from the vertically sectioned half, and the thinnest possible slice of

the cross sectioned half. Hold these up to the light. Are the faint spots and lines any easier to see?

13. Dip some thin slices of potato into a saucer or glass of water. Squeeze these in the water until it *becomes milky.* Let the water stand until after school, or, better still, over night, and you will find some *fine white powder* in the bottom of the glass. This powder is *starch.*

Information

The potato grows in the ground, but it is not a root; it is an underground stem, a very much swollen stem, yet still a stem. How can we prove this? First, if the potato were a root, it would have little rootlets growing from it. The potato has none.

Second, if the potato were a stem, shoots with leaves would grow from it. This is just what happens.

The eyes of the potato are really the little buds of shoots, or branches, and under the right conditions of heat and moisture they will begin to grow. Hence we conclude that the potato is a stem.

When a potato, or a piece containing an eye, is planted in the spring, long shoots are sent up from the eye, and these bear leaves and make the potato plant.

The eyebrow is really a little fold on which a leaf rests, and the tiny scale upon it is a leaf, very much dried and changed, but still a true leaf.

Now you can see why it was important to notice the position of the eyebrow with reference to the stem end of the potato, because the little fold and the leaf stem always lie *below* the bud that is to grow to a shoot.

If you compare the potato with the twig of a tree, you will see that the leaves of the twig rest upon a tiny fold, and that shoots grow out of the space just above. The potato has the same arrangement though it is only after careful study that we discover it.

The potato lays up food for the new shoots by packing the underground stems full of starch. When the sprouts begin to grow, they use up the starch, and it makes them grow faster and better. This kind of stem is called a *tuber*.

As the potato itself lives underground it does not need leaves, so all that remains of the leaves on this part of the stem is the small scale.

When a potato is planted in the ground in the spring or early summer, it sends up shoots which are covered with green leaves. The potato is used up by the growing plant. As soon as it can, however, the potato plant begins to make new potatoes under the ground. The new potatoes are small at first, being not much larger than peas, but they grow through the summer until they are large. In the fall or late summer they are dug up and sent to market.

The Potato Bug

After the potato plant has begun to grow and has some green leaves there appears upon it a small striped beetle called the

potato bug, the larvæ of which eat the leaves. This bug gives the farmers a great deal of trouble, because when the leaves are destroyed the plant is killed and there are no potatoes formed underground.

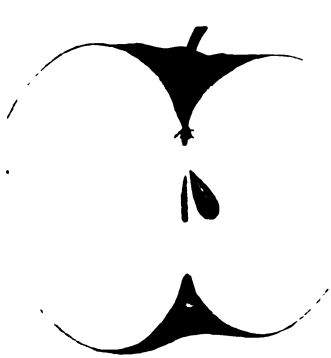
The beetle lays its eggs upon the leaves. These soon hatch into ugly red larvæ, and begin to feed on the leaves. They grow very rapidly, and by midsummer have developed into striped beetles which lay the eggs. From these come a second brood of larvæ, which pass the winter in the ground.

When spring comes they crawl to the surface of the earth, find the young shoots of a potato plant, and lay their eggs upon them. And these hatch into life-eating larvæ ready to destroy the new potato crop.

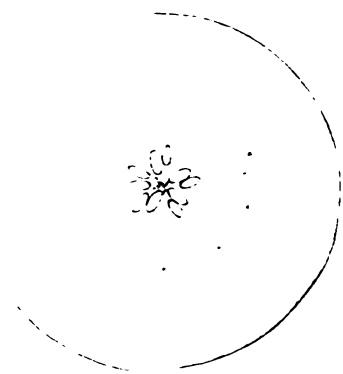
Drawing

1. Make a drawing of a whole potato and show the difference between stem end and eye end. Put in several eyes and see that they are correctly placed.
2. Make a drawing of a cross section of the potato.
3. Make a drawing of a vertical section.

Apple



Vertical Section



Cross Section

APPLE

THE APPLE

Material

Two apples, preferably red, for each pupil. Pins, or wooden toothpicks; knives. Just previous to the lesson the teacher should have pared several apples, or at least enough to give an inch or more of peel to each pupil at § 11. Keep these in water to prevent drying and discoloration, but before giving out remove surplus water on a soft towel or blotter.

Laboratory Work

1. Take an apple in your hand and notice —
   a. *Color.*
   b. *Shape.*
   c. *General size.*
   d. *Marks*, if any.
   e. *Texture of skin; shininess.*
   f. *"Feel" of skin.*
   g. *Stem* and *stem end.*
   h. *End opposite to stem*, or blossom end.
2. Has the apple a *smell?*
3. Has the apple a *pinch-sound?*
4. Look carefully at the stem and stem end; describe this end and the way the stem fits in it.
5. Examine the blossom end; do you see *five little dry points* sunk into a kind of pit?
6. Feel the skin. Now rub one cheek of the apple briskly upon your sleeve; what happens?

We must try to find out what causes this; so look for a spot on the apple which is not shiny and scrape it with your knife, taking care not to cut the skin. You should obtain a *thin white shaving.* This is *wax.*

Scrape the apple in other places, and you will find that it is coated all over with a thin layer of *apple wax.*

7. How can we prove that this is wax?

When grease or wax is put on paper, what happens? Put a little apple wax on paper. It will have to be heated, but a candle or even a match will do.

Does the apple wax mark the paper?

8. If you drop wax or grease on water, what happens? Try this with the apple wax; does it behave the same way?

9. If you burn grease or wax, what happens? Take a little apple wax on a bit of wire or a hat pin and hold it in the flame of an alcohol lamp. If you have no lamp, a candle or even a match will show it.

It is rather hard to perform this last experiment successfully because the little flame from the wax flashes so quickly.

10. Pick into the skin with a pin or toothpick and see how thick it is. What is under the skin?
11. [Give out pieces of peel.] Look at a piece of the peel; do you see the soft juicy pulp on one side? Scrape this pulp off with a toothpick; hold the skin up to the light. Describe it.

Vertical Section

12. Cut an apple vertically in halves. Set the knife close beside the stem, but do not try to cut through the stem itself. Notice —
    a. *The white pulp with the thin layer of skin.*
    b. *The core.*
    c. *The blossom end.*
    d. *The way the stem is fitted into the apple.*
13. Examine the core; notice the *seeds;* the *core plates.* Pick off a core plate and notice how *horny* it is; it is something like your finger nail.
14. How do the seeds lie in the core? (This is a hard question, and very few children will be able to answer it.)

Cross Section

15. Cut a *cross section.* Notice the *five-pointed star* in the center. What does the star contain?

Notice how two core plates meet and make a little

case into which the seeds fit. How many seeds are there in each case? How many in the whole core?

16. Describe a seed. Now try to find a seed case in which you see only one large brown seed; look into this case very carefully and see if there is not also a very tiny seed about as large as a pinhead.

Some seeds do not grow and ripen, but always remain small. If you will count all the seeds, both large and small, you will probably have *ten.*

17. Look again at the half apple and find a ring of green dots around the core. Now there is an exact number of dots — what? And they are situated in a particular way with reference to the core. Can you describe it?

18. Cut the thinnest possible slice of apple and hold up to the light. Try to describe the pulp.

19. Eat a piece of apple. Describe the *taste.*

20. Cut a small piece of apple and squeeze between your thumb and finger. Do you see a small drop of juice?

Squeeze a piece of skin; squeeze a seed; do you find juice in these? Where is the juice in the apple?

Information

There are many kinds of apples, as you will know if you take the trouble to count the kinds you have seen. Yet these are but a few of the many varieties that have been cultivated, for the number now reaches thousands. There are large apples and small apples, sour apples and sweet apples, and apples of nearly all shades and mixtures of yellow, green, brown, and red. But, like the pear, there are no blue or purple apples.

No other fruit in America is so widely cultivated as the apple, and many animals like it as much as we do. Horses and cows and pigs are very fond of apples, and elephants and bears eat them greedily. I once knew a little dog that always begged for a bite if he saw any one eating an apple. Every one knows how much canaries like them.

It would be interesting to make a list of all the animals, birds, and insects that will eat apples. Probably no one has ever tried to find out just how many there are.

The apple is our most valuable fruit, partly because it keeps so well through the winter, partly because it has so many uses.

Count all the things which you know that are made of apples. You will probably omit one of the most important, and that is *vinegar*. Cider vinegar is made from the juice of apples. The apples are ground and then they are put into a cider press and squeezed until all the juice has been pressed out.

At first the juice is sweet. This is called sweet cider. But soon it begins to ferment and then it stings the tongue when you drink it. This is hard cider.

If hard cider is allowed to ferment still further, it becomes sour. It is then what we call *vinegar*.

Home Work

Cut slices of apple, some thick and some thin, and leave them on a plate over night. What change has taken place in them by morning?

Carefully scrape some pieces of apple paring so that all the white pulp is removed. Leave them on a plate for a few hours. How do they change?

Drawing

1. Make a drawing of a whole apple showing the stem end and stem, and the blossom end.
2. Make a drawing of a vertical section showing curves at stem and blossom ends: stem: and points at blossom end: core plates and seeds. Be careful when you draw the core not to show the seeds in both right and left hand cases, because it is almost impossible to cut through two seed cases when the apple is cut exactly in the middle. Can you discover why?
3. Make a drawing of a cross section showing the five-pointed seed case and the green spots.
4. Make a drawing of a seed.

APPLE BLOSSOM AND YOUNG FRUIT

THE APPLE BLOSSOM

Material

One apple for each pupil. One twig with growing leaves. If possible, apple blossoms should be obtained so that each pupil may have a small branch. The lesson will fall at the time of year for these in the spring term; in the fall term the plate accompanying this lesson will have to serve the purpose, but the teacher ought to return to it in the spring and have the facts verified by an appeal to the real blossoms.

Laboratory Work

1. Examine the *blossom end* of the apple very carefully and notice *five small points.* These look like the tips of dried leaves and are sometimes brown and sometimes green. It may not be easy to see these points. Often they are very dry and break off.

   Lift up one or two points; find a *little hollow* under them out of which are growing *some fine brown hairs.*

2. Cut the apple horizontally half an inch from the blossom end. Examine this section; what do you see in the center?

   Cut again, half an inch from the first cut. Examine the section and compare with the previous one.

   Cut a third slice and a fourth, if the apple is large enough. Lay these slices, or sections, in a row, beginning with the blossom end. Examine and compare the sections.

3. Turn the piece with the blossom end so that the skin and the five little points are up; lay this beside the middle section showing the core plainly. How many points are there to the core? How many points at the blossom end?
4. If you have an apple blossom, try to find something that is like these five points. If not, turn to the plate and look at the picture of the apple branch in blossom, and try to find points like them.[1]
5. Notice the *pink and white* color of the flowers. Notice the leaves or *petals* of which each flower is made. Count these on one large wide-open flower; how many are there?
6. Do you see any small green points anywhere in the picture which are at all like the dried points in the apple? Where? (Examine the young apples in the lower part of the plate.)

Information

The questions we have to answer are, *What has the blossom to do with the apple?* and then, *How does the apple grow from a small green ball to a big red apple?*

If you will look at the picture of the apple branch with the blossoms, you will see in the center of each wide-open apple blossom a tuft of hairs with little yellow balls on the end of them,

[1] Leave the matter unsettled for the moment until a clear image of the blossom has been obtained, then decide in § 6.

and five little greenish threads like hairs in the midst of them. The hairs with the yellow tops are the *stamens*, and the greenish yellow ones are the *pistils*. The yellow balls contain a powder called *pollen*, which the wind blows on to the greenish threads. The threads carry the contents of the powder down inside the small green ball at the base of the petals, and this powder makes the seeds ripen. If you find ten seeds in the apple you have just cut, you will know that each of them had some of this powder to make it grow and turn brown. If you find any seeds as large as pinheads, you will know these had none of the powder, or *pollen*, and so they did not develop.

When the petals of the apple blossom fall off, they leave behind the stamens and the pistil, which is the baby apple, and the five points which you find in the apple. Figure 2 shows you what an apple twig looks like when all the petals have fallen from its blossoms. The five points make the *calyx* of the apple blossom.

The stamens and pistil soon begin to dry and turn brown, and the points get rather dry too. The baby apple begins to swell. It grows larger and larger. At first it looks like No. 1, then like 2, 3, and then 4, in Fig. 3. You see that the stem is *not set into a hollow*, neither is the blossom end depressed. Here is a problem for you to work out.

Problem

Why does not the apple remain the *same shape, only larger, when it is ripe?* Why do the stem end and the blossom end *sink in* on the ripe apple and not on the very young apple?

If you study an apple carefully and cut a vertical section of it, and then examine the core, you may be able to solve this problem.

How the Worm gets into the Apple

Probably some of the apples were wormy and you wondered how the worm got into the apple, particularly if you could not find any hole for him to get in by.

This is how it happened. In the spring, when the trees are in blossom, a small moth called the coddling moth came out of its chrysalis and flew about the apple blossoms. After the petals dropped off, and while the baby apple was very small, the moth laid an egg in the upturned cup made by the five points of the calyx.

The egg soon hatched into a small worm, which bored its way into the apple. There the worm made its home and lived by eating the apple until the apple was ripe and dropped off the tree.

In the fall the worm eats its way out of the apple and crawls to the tree trunk.

It finds a little crack or place in the bark and spins itself a cocoon, and there it sleeps all winter until the spring comes, when it hatches out into a moth. This moth lays eggs in young green apples, just as its mother did the year before, which hatch into apple worms; and these, too, spin cocoons in the fall and come out as moths in the following spring.

And so it goes on year after year, until you may well wonder why you ever have any apples without worms. It is here that the birds are your friends. They like to eat the apple worms as much as the worms like the apples. They cannot get at the

worms, however, while they live in the apple, because they never come out, but spend all their days in the dark inside. They have no windows or doors, and the little hole they bored when they went in soon closed up as the apple grew.

The birds wait until the worm makes a door and comes out, then, if they see him, they pounce on him and eat him. In this way hundreds and thousands of worms are destroyed.

But some worms succeed in reaching the tree trunk and in spinning their cocoons. You might think they were safe then, but they are not. The birds have learned to look under the cracks and edges of the bark for these sleeping worms, and they pick them off and eat them as fast as they can find them. This is one reason why not all apples are wormy; and this is one great reason why we should not kill the birds, for they help to keep the worms from ruining all the apples.

The Tent Caterpillar

The apple tree has many other enemies beside the apple worm. Some of these attack the roots, some bore under the bark, some eat the leaves. One of the worst is the tent caterpillar.

The tent-caterpillar moth lays a little bunch of brown eggs around a twig, looking exactly like a piece of the bark. The eggs hatch into caterpillars.

Now the brother and sister caterpillars have the curious habit —curious among caterpillars, at least—of making a house for themselves and all living together.

Around the end of a branch they spin a tent. Into this they creep at night after eating nearly all day. As they grow they

make the tent larger and larger. Soon all the leaves near the tent have been eaten. And thus they keep on until a large tent has been formed and every leaf on the branch destroyed.

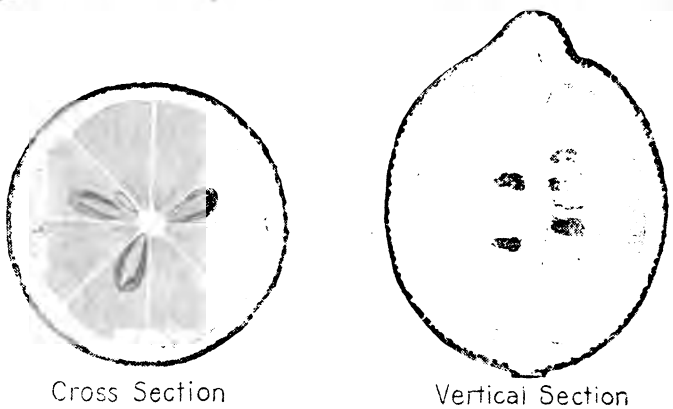
They are very secure in their tent. It not only protects them from rain but from the birds, who are afraid to get tangled in the fine tough web.

An Outdoor Problem

Here is a problem for you. Have you ever seen the trunk of an apple tree covered with rows of holes? Did you know that these were made by a bird? Now what bird made them and why did he do it? Is he a friend or an enemy of the apple tree?

Drawing

If you have no fresh apple blossoms, it will be a good plan to make a drawing of a flower, a bud, and a leaf by copying the plate, and later, when you get some real ones, compare them with the picture.



LEMON

THE LEMON

Material

Two lemons for each pupil. (One lemon per pupil will answer, provided the pupils work in pairs, the one cutting his lemon horizontally, the other vertically and exchanging.) A sharp knife; a piece of paper on which to cut the lemon.

For the study of the oil provide one sheet of white paper per pupil; a glass or pan of water (the small glasses mentioned in the material for the potato are the best, but common paint pans or saucers can be used); a bottle of oil of any kind; an alcohol lamp and a box of matches. If the lamp is not obtainable, use a candle, but it is a good plan to let the pupils observe the burning of the oil in both the yellow flame of the match and in the colorless flame of the alcohol. It is needless to say that these materials should not be given out to the class until § 13. [This is a long lesson, but if worked through rapidly to a climax will give the young pupils a sense of having learned a great deal. The drawings are omitted for this reason, and because the orange is essentially the same.]

Laboratory Work

1. Examine the lemon and notice its *color* and *shape.* Is there any difference in the two ends?
2. Look at the pointed end or "nose" of the lemon; do you find a small brown or black spot on the end of it?

   Look at the opposite end; you will find one of two things, either a *little brown or green button*, or a *little round hole*, the "*buttonhole.*"

   If you find the "button," pick it out and then put it back, and see how exactly it fits the "button-

hole." This "button" is really the end of the stem which held the lemon on the tree.

3. Examine the skin and find the *small dents that look like pin pricks.* Are these all over the lemon?

4. Has the lemon a *smell?* Describe it.

5. Has the lemon a *pinch-sound?* You must make sure of this, but you need not try to guess about the inside — because you cannot!

6. Press the lemon quickly to your cheek; does it feel *cool?*

Cross Section

7. Set your lemon on a clean piece of paper. Make a *cross section.*[1] What runs out when you cut it? Dip your finger in the juice and *taste* it. Is it sweet? What is its taste?

8. Notice the *ring of skin* and the *almost transparent juicy pulp.*

   Look at the *white spot in the center;* the *radiating lines that run from it to the skin.* Now partly close your eyes and look at the section. Do you see a *bicycle wheel* in the lemon?

[1] Only alternate pupils do this, unless each has two lemons. The knives should be wiped at once on a damp cloth to prevent discoloration, which injures the next section cut.

9. Look closely at the skin. Notice that the *yellow color is all on the outside;* that the *inside is white.* Do you see *small round yellow spots* in the outer edge of the skin?
10. Examine the pulp of the lemon. Notice again the *white spot in the center;* the *lines that radiate from this spot.* Count the lines. The lines are the partition walls between the segments of the lemon. How many segments are there?
11. Notice the seeds. Just where are they, near the center or near the sides?

Vertical Section

12. Make a *vertical section* of the lemon. Notice the thick white end or "nose"; the *little pit* where the "button" was. In the center of the lemon you will see a *long white line* made by the meeting of the segments. You can push these segments apart with a toothpick or pencil point.

13.[1] *The skin* is now to be carefully studied. Remove a long piece from one of the halves, taking care not to bend it very much or to break it. Feel the white inner portion, and pinch the piece

[1] Give out pieces of white paper and glasses of water at this point. Reserve the matches.

gently and see how *leathery* it is. Perhaps you can see now why the lemon has no pinch-sound.

14. Take this strip of skin with the yellow side up and bend it gently between your thumb and finger until it is nearly doubled, and then give it a *quick, hard pinch.* If you do this rightly, a *fine spray* flies into the air.

Hold it against the light and watch the spray fly. Do this a number of times, but remember that you have to pinch the peel in a new place each time if you want to see it.

Now look at your fingers and see if any of the spray has been squeezed out upon them. Rub them together. Smell them.

The problem is to discover what the spray is.

15. Hold a piece of paper so that the spray will fly out upon it. Does it mark the paper? Does it stay on the outside of the paper, or sink in?

Hold the paper up to the light. What do you see?

[It will save time and subsequent cleaning up of juice if the teacher has previously prepared slices of lemon peel by skinning several lemons and gives out two small strips to each child.]

16. Hold the yellow side down and squeeze some spray into the glass of water. Now if you set the glass on the side of your desk nearest the light and

you yourself move away until the light strikes it just right, you will see that the *spray floats on the water in large, flat drops.*

Let us now test *oil* and see how that behaves.

[The teacher performs the following experiments rapidly and *asking no questions;* the pupils observing.]

17. (*a*) On several pieces of white paper drop one or more drops of oil. Hold these up to the light, then pass them around the class.[1]

(*b*) In several glasses of water drop a single drop of oil. Set these glasses in convenient places and let groups of pupils gather around and examine.[1]

(*c*) Taking a drop of oil on a hat pin or wire, hold it in the flame of an alcohol lamp and burn it; then a second drop in the flame of a match and burn it.[1]

18. The lemon spray did two things the same as the oil — what were they? Will it do the same when it burns?

[The teacher makes the test first; pupils watch, and as convenient, repeat.]

19. Let the spray fly through the flame of the alcohol lamp. What happens?

[1] The teacher should at the same time say, "This is what *oil* does when dropped on paper"; or "when dropped on water"; or "when placed in a flame."

Let the spray fly through a match flame. What happens?

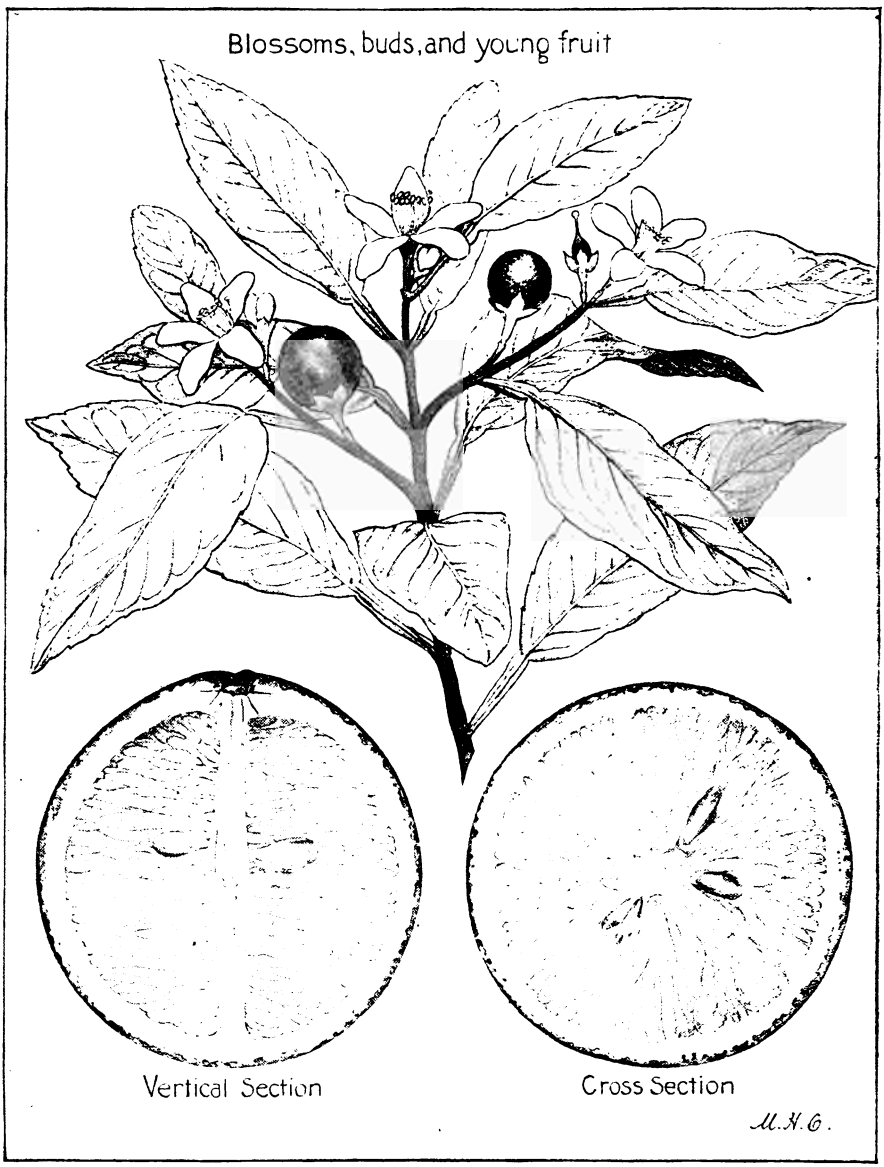
What do you conclude that the lemon spray is?

20. Our problem is now solved. The lemon spray is *oil.*

If, now, you will look again at the skin, you will see the spots that you found in § 9. These spots are little bags or sacs and contain the oil. When the skin is pinched, the sacs are pinched and the oil flies out.

21. We can therefore put the following table on the blackboard: —

Oil	*Lemon spray*
Marks paper	Marks paper
Floats on water	Floats on water
Burns	Burns
Lemon spray is oil	


Blossoms, buds, and young fruit
Vertical Section
Cross Section
M.H.G.

ORANGE

THE ORANGE

Material

One orange for each pupil may be made to answer, provided alternate pupils cut cross and vertical sections and exchange. Small, cheap oranges will do as well as large ones.

If the children are to take the segments out of their own oranges, they should be told the day before to bring towels, the ends of which should be wet before the lesson.

Laboratory Work

1. Examine the orange and notice its *color* and *shape.*
2. Is there any difference in the two ends? Do you find either a *small brown or green button*, or *a small round hole* at one end? Is there anything like this in the lemon?
3. If there is a button in the buttonhole, take it out and look into the buttonhole. You will find on one a ring of small dots, on the other a ring of small holes which exactly correspond. On which are the dots?
4. Has the orange a *smell?* Rub the skin hard on one hand and see if the smell is plainer.
5. Has the orange a *pinch-sound?* Guess why it has not.
6. Press the orange to your cheek or forehead. Put it

first in one hand, then the other. Does it feel cool? Does it feel as cool as the lemon felt?

7. Find the *small dents in the skin* like the dents of the lemon.

   Find some *small, clean-looking spots* in the skin.

Cross Section

8. Set the orange upon a piece of paper and make a *cross section.* Is there any juice on the paper when you have finished cutting? *Taste* it, and compare it with the lemon. Is it as sour as the lemon? Very few oranges are as sour as lemons, but yours may be. Some oranges are sweet. Which is yours? Some oranges are rather sweet, and some rather sour. Describe the taste of yours as accurately as you can.
9. In the cross section notice —
   a. *The circle of skin or peel on the outside.*
   b. *The juicy, orange-colored pulp inside.*
   c. *The seeds.*
   d. *The white spot in the center.*
   e. *The radiating white lines from center to skin.*
   f. *The exact number of radiating lines.* [Count.]
   g. *The number of segments.*
   h. *The fine lines inside each segment.*

i. *The position of the seeds in each segment.*
j. *The two layers of color in the skin.*
k. *The small, round, orange-colored bodies in the outside layer of the skin.*

Vertical Section

10. Make a *vertical section* and notice the long, thin, white line running down the middle; the *even layer* of skin.

Look at the plate of the lemon and compare this even layer with layer over the lemon, particularly with the part we called the "nose."

Notice the *little pit* at the stem end.

11. You must now get out one whole segment without breaking its delicate covering.

Hold the segment up to the light. Are there any seeds in it? How many?

Rip open the narrow edge with a pin or a knife point and throw back the white skin on one side. Do you see the little *juice bags* or *juice sacs* packed close together lying across the segment?

12. Try to get out one of these juice sacs without breaking it. If you succeed in getting a whole one, lay it on your finger and prick it with a pin. You will find in it *one drop* of orange juice.

Try several of these and see that each one contains a drop of juice.

13. *The problem* now is to see if the lemon peel and the orange peel are alike. How will you show this?[1]

Home Work

Can you find out in how many things the orange and the lemon are alike? In how many they are different?

Copy this table; wherever the orange and lemon are alike, write the word "alike" in each column; where they are not, write the word "different."

	LEMON	ORANGE
Color		
Shape		
Taste		
Kind of skin		
Oil in skin		
Radiating lines in cross section		
Position of seeds		
Segments		
Juice in small juice bags		
Kind of seeds		

[1] The teacher should let the pupils suggest the tests, and there should be at hand such apparatus as will be needed to allow them to perform the experiments and state the results to the class. It is not necessary that all should do them.

Information

If you have made out the table and filled it in correctly, you will find that the lemon and orange differ in three things, — color, shape, and taste, but are alike in seven other things, and these are the most important. The likeness does not end here, however. Look now at the plates representing the lemon and the orange. There is a spray of blossom on each plate. In shape of leaf, in form of blossom and bud, and the color of leaves and blossoms, they are so much alike that many people cannot tell them apart. Both grow on small trees, and these, too, are very much alike. So you see here two very interesting fruits, which at first sight appear to be very unlike, but on closer study are found to be almost identical.

Oranges and lemons grow in warm countries, and are raised in great quantities in Florida and California, whence they are sent to New York, Philadelphia, and Boston, and other large cities.

Perhaps, if they could be more widely cultivated they would be more used, but the frost kills the trees and they cannot be grown where the winters are cold.

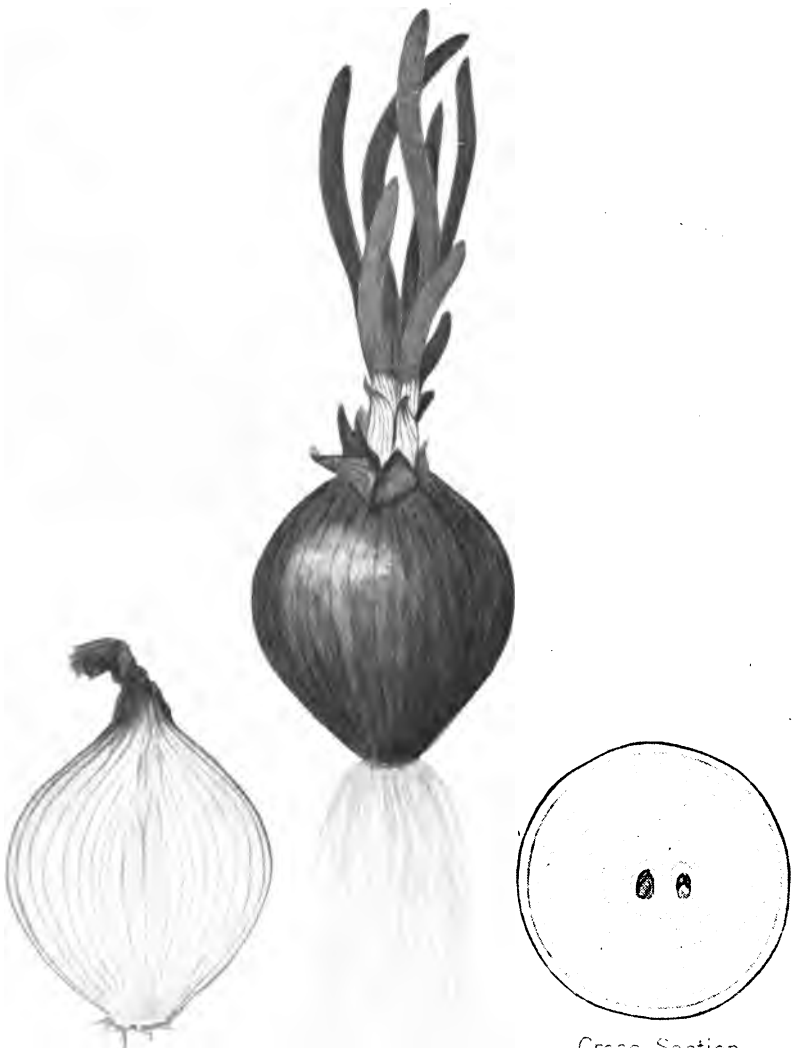
But even if oranges were as cheap and plenty as apples they would not take their place. Try to imagine an orange pie or dumpling, baked oranges or orange sauce, and you will see why!

Nor do the animals like them so much as we do, though perhaps this is because the skin is not good. Offer an orange to a horse some day and see if he will eat it.

You may have noticed how little the color varies. It is bright yellow or bright orange, and sometimes russet, but never green or red or purple or blue, if the orange is ripe. And the shape is as constant as the color.

Drawing

1. Make a drawing of a cross section and show the outer ring of peel; the white center; the radiating lines; the seeds. Be sure that you get the *exact number* of lines and the correct position of the seeds.
2. Make a drawing of a vertical section.
3. Make a drawing of a seed, and of one of the small juice bags.
4. Copy a blossom from the plate, and a leaf.



ONION

THE ONION

Material

Two onions per pupil; pins; knives. The onions should, if possible, be red, as the concentric rings show much better in the red onion than in others.

Laboratory Work

1. Take an onion in your hand; examine, and notice *color; shape; general size; its two ends*, one rather pointed, the other rather flattened.
2. Has the onion a smell?
3. Has the onion a *pinch-sound?* How would you describe it?
4. Look carefully at the outside skin; now raise a piece of it with a pin. What does it seem like?
5. Pick off a good-sized piece of skin and shake it between your fingers; what sort of a sound has it? Notice how very *thin* it is; what would be a good name for it?
6. Notice the *fine lines* on the outer skin. Which way do they run? Where do they begin and end?
7. Turn the onion so that the flattened end is uppermost, and examine the *rough brown patch* and the hairs growing out of it. These hairs are the *roots* of the onion. Notice how the paper skin ends at the rough brown patch.

8. Pull off a piece of the paper skin close to the rough patch. You should see a *neat little row of small white "teeth."* If you tear off more paper skin, you will find that the "teeth" form a ring around the brown patch. What the "teeth" really are you will discover about a week after you have planted the onion.
9. Examine the *twisted end* of the onion. Feel it and notice how brittle and dry it is. Pinch this end. In some onions (but not in all) you can feel a little hard point inside the "paper twist." We are to discover what this twist is.

Vertical Section

10. Make a *vertical section* running exactly through the middle of the *point* and the center of the *rough patch.* Open out the halves.

    In the middle there lies a *greenish yellow shoot.* This is made by the leaves of the onion that are going to grow when the onion is planted.
11. Notice that this shoot starts from a *little round mass* that looks something like a *white cork,* and that the roots grow out of this on its under side.
12. Notice the *layers* or *plates* on each side of the shoot.

Are they the same thickness at both ends and in the middle?

Where are they thickest?

Are all the plates equally thick?

Which are thinner, the inside ones, or the outside?

How thick is the last outside plate?

13. Now raise the shoot with a pin or a toothpick and see if you can make out the *long, thin leaves, lying one inside the other.*

Cross Section

14. Cut a *cross section* of the second onion. Notice the *one or two* (sometimes three) *yellow-green spots.* Look at the vertical section and tell what these spots are.

Notice the concentric rings around the shoot or shoots. Are all these rings the same width? Where are they narrowest?

15. Look carefully at the sprout. The lines you see show the leaves. Note how these leaves lie one inside the other.

16. Take the top half of the onion in your left hand. With your right, lift off the *paper cap.* Next lift off the "tent," which is the layer just under the paper cap.

You must now try to find the "*fairy's dancing skirt.*" This is not easy. Take off a second tent and look inside of it. *It is lined with a most beautiful white gauze.* With great care this can be pulled out entire, and you will see that you have a seamless skirt that would fit a fairy as tall as your finger.

Each "tent" is lined with a "fairy skirt."

Take the whole top of the onion apart and get out all the "skirts." Are they the same size? Where are the larger ones? Where the smaller?

Hold one of the skirts up to the light and examine it closely.

17. Place the "tents" in a row, beginning with the smallest. Cover the smallest with the one next in size, this with the one next, and so on until you have built up the half again. You will now understand how the "tents" fitted over one another; or one inside the other.

The same arrangement is true of the lower half. But to take the lower half apart you must first cut out the white mass or "cork" at the bottom.

If you do this, you will find that each tent is *one half of a hollow ball;* and that there are as many hollow balls as there are "tents."

Each of the hollow balls is a kind of leaf. The outside one is just like paper; the inner ones have a paper top which makes the twist. These leaves do not grow any farther, and it is only the yellow ones in the center that shoot upward and turn green.

Home Work

Do you think you can find out what happens at each end of the onion? Ask your teacher for a small piece of pasteboard a little larger than the top of a jelly glass. In the center of the pasteboard cut a round hole not quite so wide as the widest part of the onion. This is to be put on top of a jelly glass filled with water. Set an onion in the hole so that the brown patch is in the water. In a few days or a week something ought to happen.

Can you find out anything about the row of "teeth"?

How long is it before the sprout shows its head?

Watch the onion for several weeks and find out everything that occurs.

This work should be done at home, as it takes several weeks for the onion to grow. Do not let the water dry up in the glass, or get lower than the tips of the roots, or the onion will die.

Drawing

1. Make a drawing of a whole onion and show the paper twist at the top, and the lines running down from the twist.
2. Make a drawing of a vertical section and show the shoot in the center; the layers formed by the leaves; the "cork" in the bottom; the small dried roots.

   If this drawing is carelessly made, all the leaves or layers will be the same thickness. Is this correct?
3. Make a drawing of a cross section. This is very hard to do if your onion has two sprouts. Your drawing will probably be wrong, but can you tell why? The reason has something to do with the ball-like leaves.
4. When your onion has begun to grow at home, make a sketch of it.

BEET

THE BEET

Material

Two new beets for each pupil; pins; knives; pieces of white blotter about 3 × 3 inches. (If pupils work in pairs, one beet for each will answer. Let every second child cut his beet horizontally and give half to his companion, from whom he receives in return a half cut longitudinally.)

Laboratory Work

1. Examine the beet and observe its *color* and *shape;* the *long crimson leaf stems;* the *long tap root.*
2. Look for *marks* or *spots* on the beet and find the fine brown root hairs growing out of them.
3. Has the beet a smell? Would you call this smell sweet? Pungent? Earthy?
4. Has the beet a *pinch-sound?* Be careful not to mistake the rattling of the leaf stems for the *pinch-sound.*

   Knock the beet on the desk and listen to the sound. Now guess from this and the pinch test whether the beet will be soft and juicy or hard when you cut it open.
5. Look at the *leaves* and *leaf stems;* what is the *color of each?* Can you see the *veins* in the leaf plainly? Why?
6. Hold a leaf up to the light and look at the veins; do

you see many veins, or only a few large ones? Where do the veins start? Where do they end?

7. Break off a leaf stem close to the beet; do you see a *tiny green leaf* or *shoot* at the base of it? If not, break off another and examine it.
8. Break back the leaf stems one by one until you come to a *small green leaf partly rolled up*, and two or three *very small green leaves* folded lengthwise. This is the place from which the young green leaves grow. Can you make out how they are folded?
9. With a pin raise a little piece of skin and notice the *bright red flesh underneath.*

Cross Section

10. Cut a cross section of the beet. Notice the *red and white concentric rings.* These look something like the rings of the onion. Look closely at them and tell how they differ from the onion.
11. Press one of the halves firmly down on the piece of blotter, and see if it will paint its own portrait.
12. Cut the *thinnest possible slice* and hold it up to the light. Notice the *beautiful color;* the *even, smooth color of the red;* the spots and lines in the white rings.

13. Make a cross section at the place where the beet narrows into the thin part of the root. Notice the *white spot in the center;* the *small white rings* around the spot. If you press this quickly and firmly to the blotter, it will probably paint its picture.

Beet portraits are sometimes very easy to get, and sometimes they are not. Usually the best are obtained where the root begins to taper. The cut surface must not be allowed to dry before pressing on the blotter.

Vertical Section

14. Make a *vertical section* of the beet. Cut carefully through the middle of the long root.

Notice the *white core* running through the middle of the beet; the *layers of red and white* which start from the core and end in the core again. Notice the *irregularity* of these layers. How do they compare with the onion?

15. Where the white core runs down into the thin portion of the root you will find that it is really a thread or string of fibers. Raise this with a pin and see how long a piece you can take out of the root.

16. Now trace the bundle of fibers up to the leaf stems. These run from the root to leaves and carry water and nourishment to them.

Information

The beet is a swollen root and grows in the ground. When the winter comes, the green leaves die and the beet remains over the winter. In the spring new leaves come up, and then a long shoot, which bears flowers and seeds. After this the beet dies.

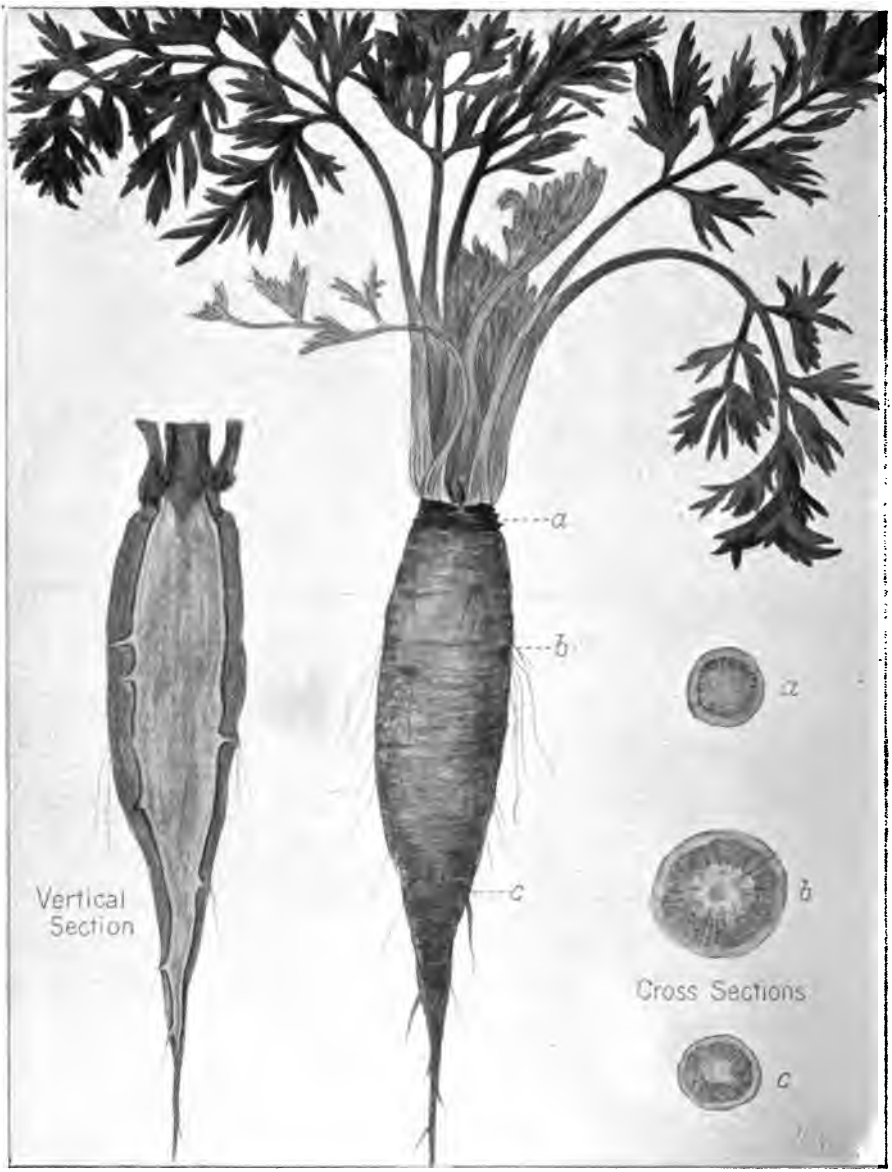
The beet lives two years; the first year it grows large and sends out leaves; the second year it blossoms, and then dies.

Plants that live only two years are called *biennials*, so the beet is a biennial.

Trees and bushes and shrubs live many years, while some small plants and vines live only one.

Drawing

1. Make a drawing of the whole beet and show *form* and *rootlets; leaf stems* and *leaves.* If the leaves have been cut away, show the stump of the leaf stem.
2. Make a drawing of the horizontal section, showing the *concentric layers* or *rings.*
3. Make a drawing of the longitudinal section, showing *layers; leaf stems; white center; rootlets.*



CARROT

THE CARROT

Material

Two carrots for each pupil. Carrots with leaves should be used if possible. New carrots can be obtained in the New York markets at almost any time of the year.

Previous to the recitation several carrots may be cut in very thin transverse sections, being kept in water until needed in § 8. It requires a sharp knife and a steady hand to do this well, and young pupils seldom have either.

Laboratory Work

1. Examine a carrot carefully, and note *color; shape; size; leaves* and *markings.* Are there any small rootlets on this carrot?
2. Examine the transverse markings and notice the *lines* and *spots.* What do the rootlets spring from?
3. Look at the wider or upper end of the carrot and notice the *dark wrinkles;* also the *green leaf stems;* or the *green stump* where the leaves were cut off.
4. If there are leaves, notice their *feathery shape; long stems; beautiful green color; differences in size.*
5. Notice how the leaf stems seem to be growing, one inside the other. Find the *outermost* leaf; the next; and the next.

Are these large leaves?

Are they the largest leaves?

Where is the largest leaf?

Are there many leaves *outside* of this?

Lay back the larger leaves very gently. Do you find a folded leaf that has not spread out?

Look below this folded leaf. Can you find one still more folded?

Below the second can you find a third still more folded?

How many of these folded leaves can you count?

Is the *smallest* leaf of the carrot an *inside* or an *outside* leaf?

Is the *youngest* leaf of the carrot an inside or an outside leaf?

Then from which part of the bundle of stems do the new leaves spring?

6. With a pin pick off a little of the *skin* of the carrot and examine.

Is the skin thick?

What is the color under the skin?

7. Smell the carrot. Just how would you describe this smell. (You may have heard the expression, "a carroty smell," used in the same way as "a carroty color.")

8. Has the carrot a pinch-sound? Be careful that you do not mistake the rattling of the leaf stems for a pinch-sound.

9. Is there any *give* to the carrot when you squeeze it in your hand? How hard is it?

Cross Section

10. Cut a *cross section* near the middle of the carrot. Notice the *concentric rings;* the *light zone* in the center; the *pinkish zone* outside.
11. Cut the thinnest slice you can; hold it up to the light, and you will see what look like "pink pins" sticking into a pin cushion.

[Give out sections made before class.]

Lay a section upon a dark surface or black paper and examine. All carrots do not show these "pins" equally well.

12. Cut a cross section near the end of the carrot, and another near the top; examine these and compare them with the slice from the middle.

Vertical Section

13. Cut a *vertical section* through the middle of the second carrot. Notice the *central core;* the *outside layers;* the *green line* that runs between the layers; the *light yellow line* running inside the green line. What happens to the light yellow line when it comes opposite a root-bearing spot?

Do the pink pins show in a vertical section?

Information

The carrot, like the radish, is really a root, though its color is so bright it hardly seems as though it could have grown in the dark earth.

When the carrot seeds are planted, they sprout and send two leaves up into the air and a root down into the ground. This root is slender at first, but it grows thicker and thicker until it is the size you see.

In the fall the leaves die, but the carrot stays in the ground. It freezes just as the beet did, but does not die. In the spring it sends out new leaves and a stem with blossoms. The blossoms make new seeds, and then the carrot dies. But the seeds fall and sprout, thus making a new plant. (Does the beet do the same?)

Have you a pet rabbit? If you want to make him a Christmas present, give him a carrot. He will enjoy it more than plum pudding or mince pie.

Drawing

1. Make a drawing of the carrot, showing lines and rootlets.
2. Make a drawing of a cross section, showing zones and "pink pins."
3. Make a drawing of the vertical section, showing lines running from rootlets and leaves.

Pea pod

Open pod showing peas

Whole pea
showing sprout

Halves of pea

PEA

THE PEA

Material

Five or six fresh green pea pods per pupil. Pins. (Peas can be obtained in the New York markets at almost any time in the year, but in winter a good many are apt to be damaged. Allow from two to three quarts for fifty pupils, according to condition.)

Laboratory Work

1. Lay the pea pods in a row; look at them, and then pick out one that seems to you medium sized and a good one. Take this in your hand and examine it, noticing —
   a. *Color.*
   b. *Shape.*
   c. *Stem.*
   d. *Small leaves at stem end.*
   e. *The point opposite the stem end, or "nose."*
   f. *The lines running from stem to "nose."*
2. Notice that one line running from stem to "nose" is almost straight. Do you see the *groove* in this? One line running from stem to nose is very much curved at the nose end. There is a ridge on this. Run your finger along each of these lines; which seems the sharper? Can you tell the two edges apart when you feel them with your eyes shut?

3. Return to the stem end of the pea.
   a. Count the small leaves.
   b. Notice the little veins in them.

4. Hold the pea pod so that the ridge is up, the straight line down. Lift and turn back the two little leaves on top at the stem end and find something that looks like a piece of *tissue paper with a very fine fringe on it.*

5. Examine the "noses" of all the pods and try to find one with a *little dry horn on the end of it.* This looks like a scrap of paper. If it has fallen off, find the *scar* on the tip of the nose where it was fastened on.

6. Hold the pod up to the light. Do you see any *dark bodies* inside? How many? What shape are they? Are they in the middle of the pod?
   On which edge are they, the straight edge or the curved edge?
7. Notice also a *network of green veins;* from which edge do the larger ones start?
8. Hold all the pods up to the light; is there any difference in the size of the dark bodies?

9. Hold a pod with the straight edge down; stick a pin

into the nose and *cut along the curved edge to the stem.* Open the pod gently. What is inside?

Notice the *color*, *shape*, and *size* of the peas.

10. Open the pod with the fingers and shake it; do the peas fall out? Why not?

11. Pick them out carefully one by one; notice the *little stalk* that holds them in the pod.

On the pea find the *spot* or *scar* to which the stalk was fastened.

Find the patch of *snow-white hairs* on the pod between each pea.

12. Open a fresh pod as you did the first. Take each side at the nose end between the finger and thumb of each hand. Pull gently so that the halves tear apart. What happens to the peas? Do they fall off? Are they all on one half of the pod? Do you find any very small peas about the size of pin heads?

13. Open a fresh pod and pick out all the peas; now look carefully at the *inside* of it, then at the *outside.* Which looks like *ground* glass? Which is bright and shiny?

14. Turn a half pod over your finger, dull side down; gently scrape the shiny side with a pin or knife

until some *green juicy pulp* comes off. Taste this; how does it taste?

15. Scrape clean a small patch of pod; underneath you will find something that *looks like stiff paper.*
Scrape all the green pulp from a half pod and find the *paper lining.*

16. Hold the paper lining up to the light. Are there any *veins* in it? How do you account for this fact?
Lay the paper lining over a printed word and see if you can read the word through it.

17. Select the largest pea you can find; break off the *stalk* and notice the scar it leaves. Near this scar there is a *dent,* and in the dent you will find what looks like a *little "tail."*

18. With a pin pick off the skin of a pea. Is the pea darker under the skin, or lighter?
Notice the little "tail" and the two halves.

19. Pick the skin off another pea, and watch it very carefully as you take it off the "tail."
You should find a very *tiny pocket* in the skin into which the "tail" fits.

20. Now, the "tail" is really a little *root* which will grow when the pea is planted. Open the two halves of the pea; notice how the root ends;

it is attached to each half of the pea. At the top of the root there is a *small round knob.* This is the head of the baby pea plant. Notice how it is attached to the two halves of the pea. These halves are called the *seed leaves.* Can you find the little grooves in the seed leaves into which the pea fits?

Information

The pea is a seed, and will grow to a new plant or vine if planted. These fresh green peas will not grow now, however. They are not ripe. Even if they were ripe, they would not grow if taken out of the pod and planted. They need to be well dried first and to rest for a while before they are ready to sprout.

If you want to try sprouting peas, get some dried peas at the grocer's. Soak them over night in warm (but not hot) water, and in the morning plant them in damp sand, earth, or sawdust. Keep the soil watered, but not wet enough to rot the peas.

In about a week the peas will sprout and little plants will come up.

Early dwarf peas can be bought in small packages at the seed stores, and these generally blossom and often bear pods when grown in the house in pots or boxes. Grocery store peas seldom blossom, but die down when they are a few inches high; so if you wish to study the growing plant at home you would better get the best seeds to begin with. Do not plant them too close

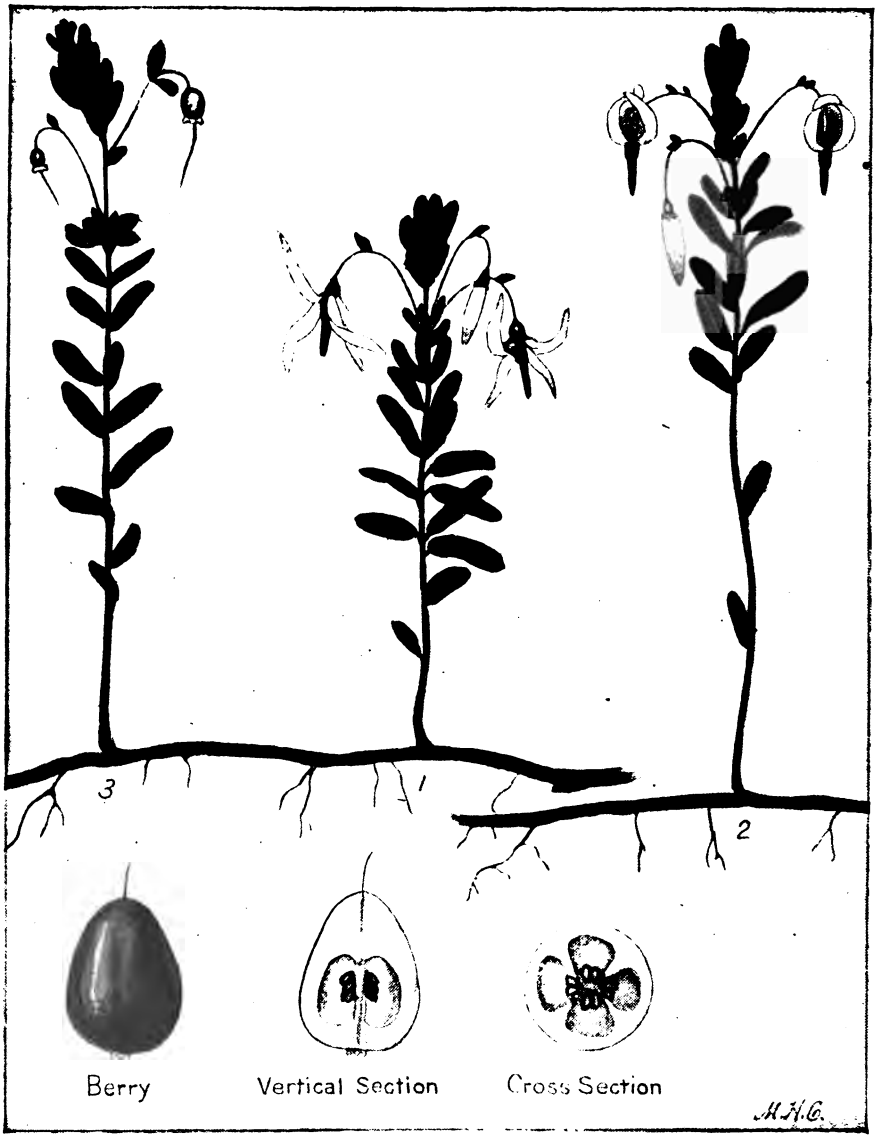
together if you wish them to flourish; four or five seeds in a small pot will be plenty, and they should not be put all together in the middle, but separated.

The pea plant is a *vine.* Sometimes the vine is very short, sometimes tall. When it is tall it has to have sticks of wood or brush to twine upon.

The pea vine blossoms and bears peas the same season, and then dies. It does not sprout again from the root, as the beet does; hence it is called an *annual* or *yearly plant.*

Drawing

1. Make a drawing of a pea pod, showing the straight and curved edge, the "nose," and the leaves at the stem end.
2. Make a drawing of an open pod, torn apart, showing peas alternating.
3. Make a drawing of a pea and of two halves, showing the baby pea.



CRANBERRY

THE CRANBERRY

Material

Half a dozen cranberries for each pupil; pin; knives.

Laboratory Work

1. Pick out a good cranberry; examine and notice *color, shape, size; shininess.*
2. If any of the cranberries have *stems*, examine them; if not, find the *spot* where the stem was attached and notice the *little pit* in which it was set.
3. Examine the end opposite the stem end; this is the *blossom end*, or end from which the petals of the flower fell. Notice the *white or brownish white points* around a little hole. How many points are there?

   Can you find a *tiny spot* in the center of the hole?
4. Has the cranberry a smell?
5. Has the cranberry a *pinch-sound?* You will have to pinch it quite hard to find out.
6. With a pin pick up a little piece of the skin. What color is the berry under the skin?

   With the knife cut off a bit of the skin about as large as your finger nail; scrape away the white

pulp that sticks to it. Hold this to the light and notice the *color.*

Take the piece of skin between the thumb and finger of each hand; pull it and see whether it is tough or brittle.

Cross Section

7. Cut a *cross section* of a cranberry and notice the *four large holes* arranged like a *cross;* the tiny *seeds* in each of these holes.

   Notice the *pink color* in the center of the cross and the white of the pulp.

8. With a pin pick out the seeds from one compartment and lay them on a piece of white paper.

   How many seeds are there?

   Are they all the *same size?*

   How large is the largest?

Vertical Section

9. Make a *vertical section.* Notice the *large holes* or *hollows,* growing wider toward the blossom end; the pulp at the stem end. Can you see where the *stem fibers run through* the thickened pulp?

10. Cut some slices down the cheek of a berry so that one of the four holes is opened, and you can see

the seeds attached to the inside, that is, to the center of the berry. They form a *little bunch* almost exactly in the middle of the berry. Do you see it? (You may have to cut several berries before this is clear.)

11. Cut a thin slice from a cross-sectioned half. Hold it up to the light and examine carefully. Does it look hard and solid?

Now take one of the cut halves and pinch it quickly so that you *hear* the *pinch-sound* and *see* the juice squeeze out.

This will help you to understand why it is that hard, solid things have no pinch-sound.

12. Take off as large a piece of the skin of one of the berries as you can get off whole. If there is any white pulp upon it scrape it off with a pin or knife, then hold the skin up to the light and examine.

Where is most of the coloring matter in the cranberry?

13. Cut a small slice of a cranberry. Taste it, and then chew it up. Is it sweet?

14. Look at the picture of the cranberry vine, page 120. This shows the vine as life-sized.

Notice the *blossoms*. Describe one.

When the bud first opens the petals hang down almost straight, but they soon begin to curl up. Can you find any blossoms in which they have curled up?

Notice the *point* that hangs down under the blossom. This point is formed of the stamens and pistil folded together.

15. After the petals fall off the berry is left hanging upon its crimson stem. This is then very small, and either green or purplish green, and has a *collar of four little points* opposite the stem. Do you see this in the picture? Did you find four points on the grown cranberry? These are the same points that formed the collar when the berry was little.

Now look at a picture of a blossom and find the young cranberry *before* the petals have fallen off. Compare this with one of your berries.

Information

The cranberry is raised mostly in the New England states, and particularly on Cape Cod, and also in New Jersey. There the people make what they call cranberry bogs by digging ditches through a marshy place and then covering the spaces between the ditches with sand. In this sand the cranberry vines are planted. They grow and spread and soon cover the sand all over.

The bogs are commonly covered with water during the winter, as a protection against frost. This has an additional advantage, because insects are drowned that would destroy the cranberry crop, for a cranberry bog has many insect enemies. The worst of these is called the fire worm. It spins a thread around a group of growing leaves, hides itself in the midst, and eats them at its leisure. The bog soon looks as though a fire had passed over it, hence the name "fire worm."

The worm is really a caterpillar which develops into a moth, and the cranberry grower who has not succeeded in drowning the caterpillar has another method of ridding himself of the pests.

The first crop of moths come out at the end of June and fly about laying millions of eggs, which will hatch early in July into fire worms and go on destroying the vines.

Now moths generally fly at dusk or in the twilight, but they are attracted by any light, and fly to it. Bonfires are built about the bogs in the early evening, the moths gather around and flutter up to them to see what they are, and fall in and are destroyed.

The vines blossom in summer, and are generally in full bloom about the 4th of July. The berries begin to ripen after the petals have fallen off.

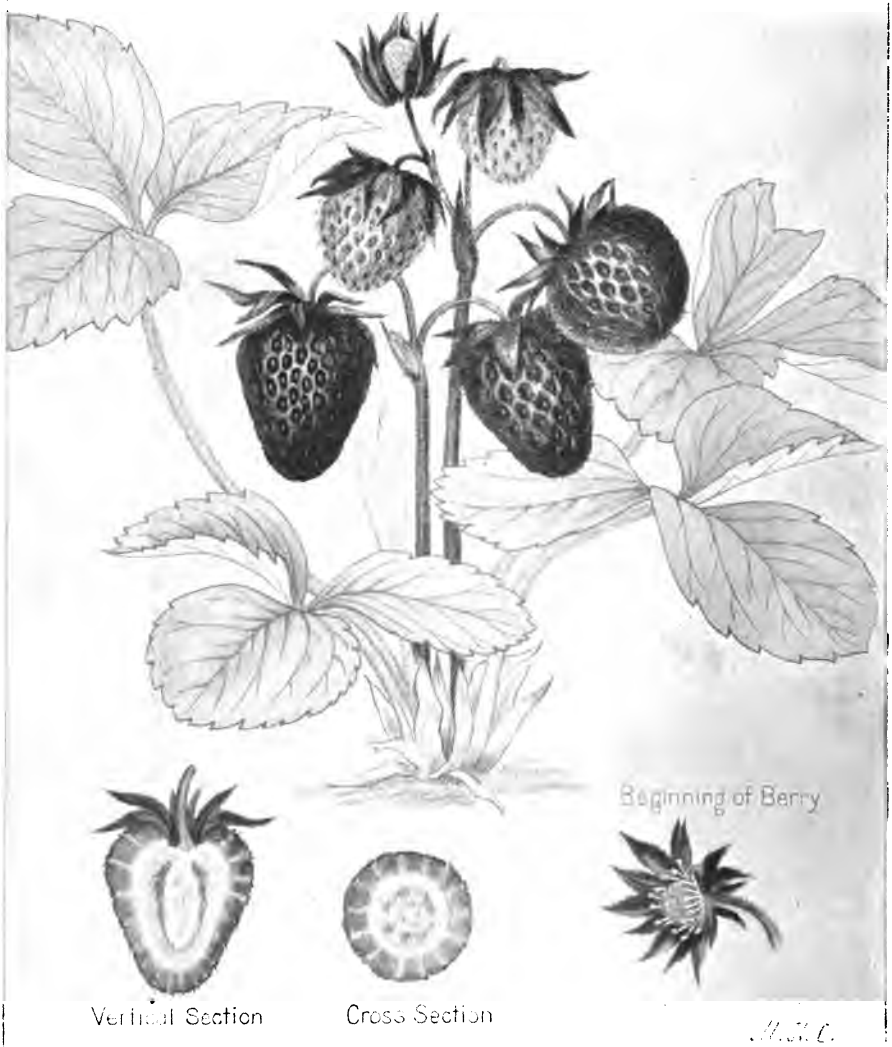
The flowers are small but very pretty. The petals are white, tinged often with pale pink. The stamens are bright orange, the flower stem deep crimson, the buds are quite pink, the leaves bright, glossy green. The plant is not very showy, however, because it is so small. The plate shows it as life-sized. If it were larger it would probably be cultivated for the beauty of its flowers.

In the fall when the berries are ready for picking the people go to the different bogs from all the country round about. Most of the schools give holidays so that the children can earn money for Christmas by picking cranberries, and while the season lasts, which is sometimes for two or three days, there is quite a picnic at the bogs.

The cranberries are afterwards put into barrels and shipped to different markets all over the country.

Drawing

1. Make a drawing of a whole berry; of a cross section; of a vertical section.
2. Sketch one of the plants in the plate, showing the stem, leaves, bud, blossom, and the stem that runs along the ground and bears the roots.



STRAWBERRY PLANT IN FRUIT

THE STRAWBERRY

Material

Four or five strawberries. Pins; knives. Allow one box of berries to twenty pupils if the berries are very large, otherwise one box to thirty. If possible have leaves also. Pressed leaves will do if fresh ones cannot be found. Where a whole plant in flower or fruit cannot be obtained use the accompanying plate.

Laboratory Work

1. Take a strawberry in your hand and notice —
   a. *Color.*
   b. *Shape.*
   c. *Size*, as compared with an apple, a pea, a pin-head.
   d. *Small seeds on the outside.*
   e. *Stem and hull.*
   f. *Difference between the two ends.*
2. Has the strawberry a *smell?* Describe it.
3. Has the strawberry a *pinch-sound?* Pinch the berry very carefully. Try to guess what it will be like inside when you cut it open.
4. Notice the *stem* and *hull.* Count the small leaves of which the hull is made. *Do these leaves meet each other* before they reach the stem and form a little round plate out of which the stem grows?

Take the stem in your right hand, the berry in your left, and pull. What happens? Does the whole hull come off, or only the stem? Why does pulling the stem pull off the whole hull? Did the hull come off easily or not?

The stem holds the berry to the stalk on which it grows; if it were not fastened rather firmly, the berry would drop off.

5. Look at the *seeds.* Notice how they *lie in a little pit or hollow.*

Are the seeds *large, small,* or *very small?* What is their shape?

The seeds are placed on the berry in such a way as to make a *diamond pattern.* Can you see this?

6. Examine a seed carefully. Can you see a *tiny hair growing* out of the end of it?

Look at many seeds and see if all have these hairs. We might call them "fairy pins," they look so much like pins and are so small.

7. Lift a little of the skin with a pin point. Is it thick or thin? Describe it.

Vertical Section

8. Cut a berry vertically. Notice the *pink layer outside.* What is the inside like?

Some berries are quite white inside; some are pink; some have a pink ring outside and a pink center. Describe yours.

9. Are there any seeds *inside* the berry? Where are all the seeds to be found?

How are the hull and stem attached?

Cross Section

10. Cut a *cross section.* Notice the *pink ring* around the outside. Describe the inside of the berry.

11. Take another strawberry and cut off its tip; above this cut a second slice; then a third, and if you can a fourth. Lay these in a row one by one, in the same order as you cut them off. Now notice how the *color zone* changes in each section. The section at the tip is quite pink. What are the others like?

12. Cut another strawberry vertically. Can you discover anything new that you did not notice with the first section? If you look closely you will see some fine *lines running from the center to the outside.* How do these run, straight or slanting? How do these slant? (Most children answer this question wrong.)

Now look at the row of horizontal sections and see if there are any lines in them. How do these lines run?

13. Eat a strawberry. First mash it just a little in your mouth with your tongue. Is it sweet? Now chew it up. Is it still just as sweet as at first? When you chew the berry can you feel the little seeds breaking? Are they hard or soft?

How nearly did you guess right about the inside of the berry when you listened to the pinch-sound?

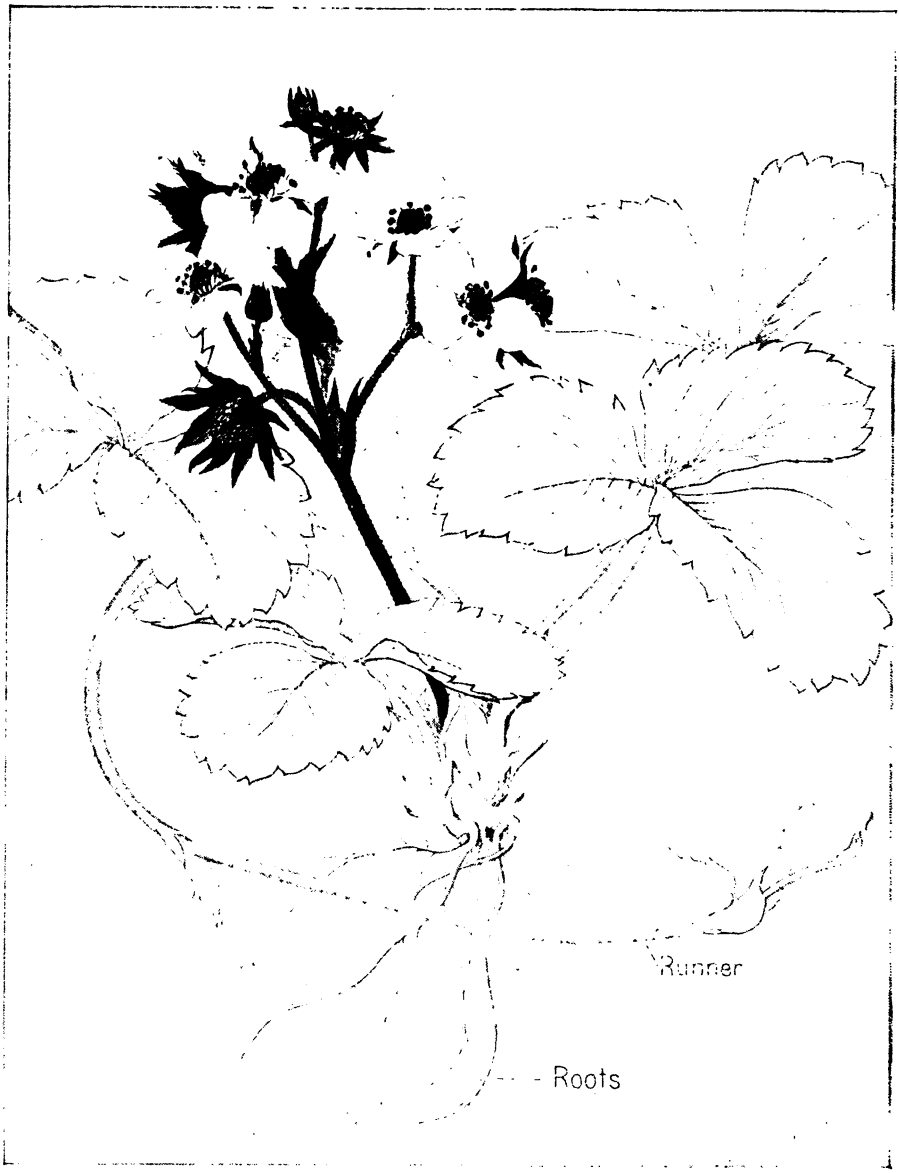
Information

The strawberry grows on a little plant like the one you see in the plate. Its leaves have three parts and the edges are saw-toothed.

The flowers are of a beautiful creamy white and have five petals.

In the middle of the flower are a great many yellow stamens around a green center. This green center is the young strawberry, which at first seems to be nothing but a patch of green seeds.

A few days after the bud has blossomed the petals fall off, and then the berry begins to grow. It is green for a long time, then it becomes yellowish, then pink, and finally red. The red is sometimes very light and sometimes very dark, depending on the ripeness and the variety of the berry.



STRAWBERRY PLANT IN BLOSSOM

Every plant bears several berries, seldom fewer than ten, but often as many as a hundred.

Few of our fruits vary as much in size as the strawberry, which has been cultivated to grow so large that sixteen easily fill a quart box, while of the smaller varieties and the wild ones, it takes hundreds to fill the same measure.

Strawberries grow wild in the country, but they are very small. Unlike most other fruits the wild strawberry is considered by most people superior to the cultivated. It is very sweet, and has a delicious flavor. Cultivation has improved the size rather than the quality of the berry.

The birds like these berries as well as we. If you find a berry with holes in it, you may be almost sure that a bird has been eating it.

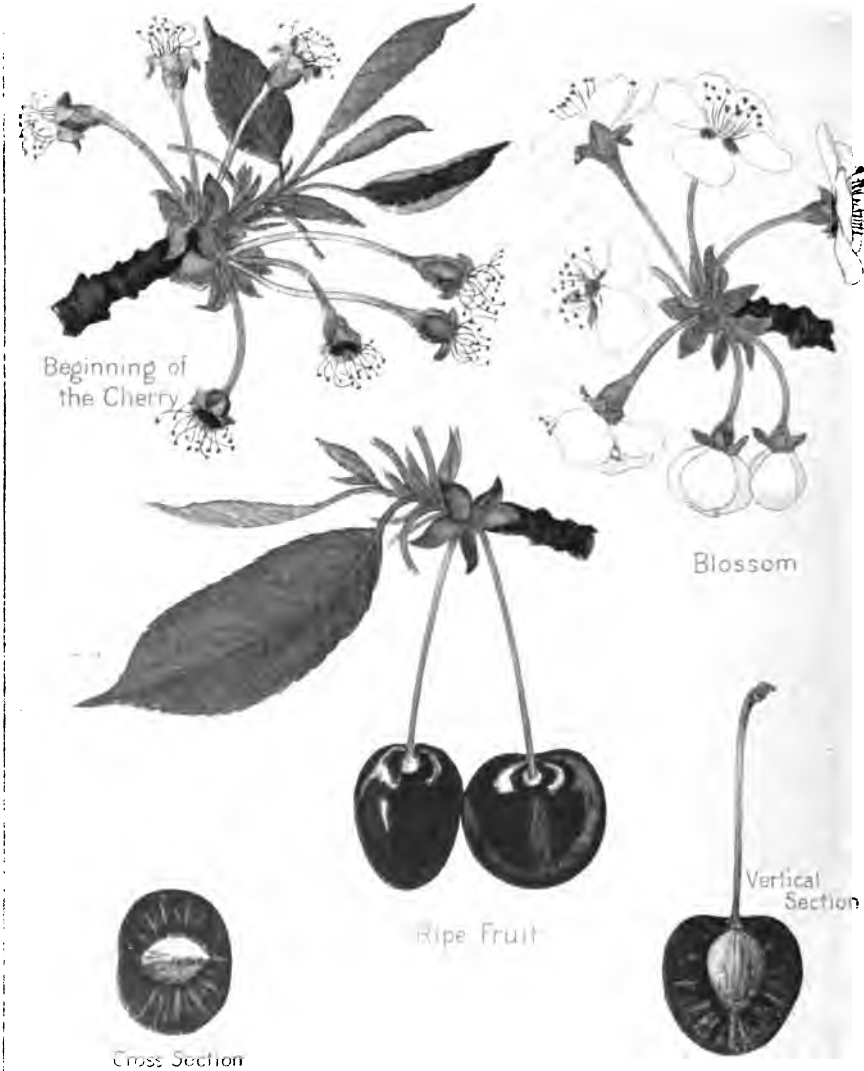
The stamens, which are yellow at first, soon dry up and turn dark brown. If, now, you will examine the underside of a strawberry hull, you will find a fringe of these dried and brown stamens. Look at the plate and you will see how they are arranged around the berry, and lie inside the cup made by the petals. So when the petals fall they still remain attached to the calyx, which we then call the *hull* of the berry. That is why we can still see them when the strawberry is ripe.

Drawing

1. Make a drawing of the whole berry, showing *shape, hull, stem, diamond pattern of seed arrangement.*
2. Make a drawing of a vertical section, showing shape, hull, stem, seeds on the outside. Show the fine

lines that run from the inside to the outer edge and represent them by very faint pencil marks.

3. Make a drawing of a horizontal section, and show the seeds, the colored ring, the radiating lines. The lines must be very faint. The colored ring may be shaded in.
4. Copy a leaf from the plate, showing size, shape, veins, serrate edge.


Beginning of the Cherry
Blossom
Ripe Fruit
Vertical Section
Cross Section

CHERRY

THE CHERRY

Material

Four or five cherries for each pupil; knives; pins; pieces of white blotter. Rulers are needed for § 2. Use, if possible, the large, red California cherries.

Laboratory Work

1. Pick out your best cherry and notice —
   a. *Color.*
   b. *Shiny, polished skin.*
   c. *Stem.*
   d. *The exact shape.*
   e. *The tiny spot* opposite the stem end.
   f. *A faint line* that runs from the stem to the spot.
   g. *The hollow* into which the stem fits.

   Lay this cherry aside to draw from.

2. Notice the *two ends of the stem; the little disk* or *plate* that fits into the cherry; the *little knob* or *handle* at the free end.

   Pull out the stem carefully and measure it with the ruler; how long is it?

3. Look at the place where the stem came out. You will find a *little round bowl* with a *white spot* in the bottom of it.

Stick a pin exactly into the middle of the white spot. If the pin did not slip, you will find it very hard, so hard in fact that the pin will not go into it at all.

Now this hard white spot is really the *bottom of the cherry stone*, so you see just how it rested on the stem, and how near it lies to the bottom of the cherry.

4. Turn the cherry over and run a pin in at various places on the cherry and notice that in some it goes in deeper than others before it touches the stem.

5. Have you seen how a drop or bead of juice follows the pin each time? Touch one of these droplets to the blotter in order to see its exact color.

6. Take another cherry; hold it with a cheek up. Stick a pin into the cheek and watch the drop of juice follow the pin. Do this several times, and on both cheeks.

Now, there is one spot in the cherry that does not bleed when pricked. Find the spot opposite the stem (mentioned in § 1 *e*). Hold the pin exactly upright, and run it into the spot. If the pin has been perfectly straight, no juice will follow it. Prove this with another cherry.

7. Eat the cherry you have just been studying. Chew it up carefully, taking the stone out of your mouth.
   Describe its taste.
   Had it much juice?
   Was the skin tougher than the inside?
   Did the stone seem large while you were eating the cherry?
   Now guess from what you have discovered by eating the cherry whether or not it has a pinch-sound.
   Pinch another cherry very carefully. Did you guess right? Has it a pinch-sound?

Vertical Section

8. Make a vertical section by cutting the cherry along the fine line, or groove, running from stem to point, and open out the halves. (This is very hard to do well, and needs a sharp knife.)
   Notice —
   a. *The thin dark skin.*
   b. *The lighter pulp inside.*
   c. *The seed*, or *stone*, or *pit.*
   d. *The faint lines in the pulp.*

9. Examine the stone of the cherry you ate. Pinch it with all your might. What do you find? Notice

its peculiar shape and the *lines* which are on it. There are several lines on one side and one on the opposite side. Follow these lines until they meet, and see if you can find the *white spot* that showed when you pulled out the stem.

Lay the stone on your desk and lay the cherry stem below it so that the right end of the stem fits the right spot on the stone. Then lay a cherry beside it with the stem nearest you, and you will see that the pointed end of the stone goes into the pointed end of the cherry. Look at the half cherry and see that this is true.

10. There is an up and down to the stone; there is also a right and a left. Examine the stone carefully and see the difference in the two sides.

Cross Section

11. Make a *cross section* of another cherry. Notice the *crimson pulp;* the *pale lines* in the pulp; the dark outer ring of the skin; the stone.

Notice also that the pulp is the same thickness all around the stone.

12. There is now a *problem* for you to solve with regard to the stone and the cherry. Exactly how does

the stone lie in the cherry? Could you tell from the *outside* of the cherry under which part of it the heavy lines on the stone will lie?

Information

If you look at the plate, you will see what the cherry blossoms are like and how the young cherry grows.

The cherry blossom has five white petals and many stamens and a pistil in the center. The stamens have a fine yellow powder which touches the end of the pistil and makes the cherry develop.

After the petals drop off, the stamens are left attached to the calyx (or cup), which then becomes very dry. The little cherry inside grows and swells and soon bursts this dry skin, which falls off, leaving the green cherry at the end of the stem.

Sometimes the calyx does not fall off, but hangs around the stem and makes a fringed collar for the cherry.

The spot on the end of the cherry shows where the pistil was attached which carried the yellow powder to the seed. This was the spot, you will remember, that did not bleed when pricked with a pin.

The green cherry does not hang down as the ripe one does, but is held up by its stem, so the pointed end of the stone is really at the top, and the round spot at the bottom. This you can see if you look at the plate.

Many birds like cherries as well as we do, and the robin is particularly fond of them and eats them on the trees as soon as they are ripe.

Drawing

1. Make a drawing of a cherry and show shape, size, stem. Represent the faint line on the cherry with a faint pencil mark.
2. Make a drawing of a half cherry, using whichever of your sections was the better.
3. Make a drawing of the stone, showing its upper end, lower end, right and left sides.

NOTE. — SUMMARIES I–III are to be reviews and summaries of the work gone over, using the plates, not the real objects. They are to call attention to differences and similarities existing between the objects studied which were passed over in the actual lessons but which are now observed and discovered. The work should be done from the book and not from memory images.

The exercises that follow are not intended *to test* knowledge but *to summarize* and *coördinate* it, and the child should make himself reasonably sure by an appeal to the book that he is answering each question correctly.

The drawings are meant to bring the term's work into rapid review before the pupil, in order to give him a feeling of the work as a whole.

SUMMARY I

1. Take a large sheet of drawing paper and make a plate showing one leaf of each fruit or vegetable given in the book. Copy these from the plates, selecting a good leaf each time. Arrange the plate carefully and write the name of each leaf under it.
2. Make a second plate in which you show the blossom of the apple, the pear, the cherry, the strawberry, the blackberry, the cranberry.

   Arrange these carefully and name each.

   You must make plates which you think it would be nice to add to the book.

SUMMARY II

1. On a sheet of paper write the numbers

   1.
   2.
   3.
   4.
   5.
   6.
   7.
   8.
   9.
   10.

   Now look through all the pictures and find the fruit or vegetable you think the largest. Write this after 1. If you find two just the same size, write them both after 1. Find the next largest and write after 2; the next and write after 3; and so on until you have a list from largest to smallest. You may need more than ten numbers. Of course you will remember that fruits and vegetables vary in size, nevertheless grapes are never as large as apples, strawberries as plums, or peas as potatoes.

2. *a.* Name a fruit that has a core.
   b. Name a fruit with a stone or pit inside.
   c. Name a fruit with seeds on the outside.
   d. Name a fruit that has four small seeds.
   e. Name a fruit whose seeds were embedded in little balls.

3. *a.* Name a specimen that was very juicy.
   b. Name one that was very dry.
   c. Name one that was very hard.
   d. Name one that was very sweet.
   e. Name one that was sour.
   f. Name one that had a strong smell.
   g. Name one that is good eaten raw.
   h. Name one that is always cooked before eating.

SUMMARY III

1. Compare the lemon skin with the pea-pod.
2. Which specimen showed concentric layers when sectioned horizontally?
3. What specimen had "tissue paper" leaves?
4. *a.* What specimen had seeds in a pod?
   b. What specimens had seeds in a star in the center?
5. *a.* Name three specimens having seeds that we do not eat.
   b. Name two specimens having seeds that we eat because they are too small to remove.
   c. Name one specimen of which we eat the seeds only.
6. *a.* What specimen is an underground stem?
   b. Name one specimen that is a root.
   c. Name one specimen that is a fruit.
7. Now copy and fill out the table on the following page: Be sure that you put all the fruits under fruits. Everything that has a seed is a fruit. And be careful to find all the *modified* leaves or *modified* stems.

Fruit	Root	Leaf	Stem

8. *a.* Make a list of all the specimens that are good eaten raw.

   b. Make a list of all the specimens that are good only when cooked.

   c. In general the ones eaten raw are fruits, the ones needing to be cooked are vegetables.

   There is one specimen that we call a fruit that is not eaten raw. Which?

   There is another specimen that is never eaten raw without a great deal of sugar. Which?

There is one vegetable that is always eaten raw. Which?

d. Did you ever eat a raw potato?

Did you ever eat a cooked orange?

Did you ever eat a cooked carrot?

Do you like radishes raw or cooked?

Are strawberries better raw or cooked?

Which would make better preserves, cherries or onions? Beets or blackberries?

Can you give any reasons why these fruits and vegetables are cooked or eaten raw?

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